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OF

MECHANICAL AND PHYSICAL SCIENCE,

CIVIL ENGINEERING, THE ARTS AND MANUFACTURES,

AND OF

AMERICAN AND OTHER PATENTED INVENTIONS.

EDITED

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Civil Engineering.

Cost of Transportation on Railroads. By CHARLES ELLET, Jr., C. E.

(Continued from Vol. VI, page 370.)

I propose now to continue to produce those details of the cost of transportation on railroads, which enter into the approximate formula for the computation of the average annual charges, preparatory to the indication of certain modifications, which, in time, will be found necessary, in order to adapt the expression more strictly to the various cases which occur in practice. A reference to the table contained in a previous number of this journal, (vol. vi. p. 323) will show with what accuracy the formula, in its present state, applies to almost every variety of roads in the Union.

But it will occur to the experienced reader, that there are certain sections of the country on which the cost of fuel is exceedingly light; others where it is very great; that there are some lines provided with a double track; some on which the engines are unusually large, or on which the company are exposed to peculiar causes of expenditure. It will be readily conceded, therefore, that a formula *strictly* applicable to all these cases, ought to be expressed in more terms than the mere length of the line, the tonnage, the travel, and the miles run by the locomotive engines—which are all the quantities that appear in the rule which has been presented. But yet we have seen that that formula, as it is, does apply and give consistent results, and results quite close enough for almost any useful practical purpose, without any correction for these varying conditions. This circumstance, therefore, needs explanation; but before explanation can be advantageously

offered, I must lay before the reader certain details which have been used in the construction of the formula. In anticipation of this explanation, however, I may observe that the true cause is, that these circumstances, which disturb the action of the general law, have very little influence compared with the value of the great items which compose the formula. I shall return to this subject again; but at present we may proceed with the determination of the values of the detail of expenses, and leave the slight corrections to be applied in consequence of these irregularities—irregularities chiefly in the prices of labor and materials—for the sequel. The reports of the various companies for the current year, will shortly be published; and by introducing the results which it is to be presumed they will exhibit, under an improving system of economy, I hope to be able to make a still closer approximation to the truth. We shall have also, in a few weeks, the results of the year's operations on the Philadelphia and Reading Railroad, from which we shall be able to verify experimentally, the influence on the cost attributable to a very large trade conducted under remarkably favorable circumstances.

I propose to consider next—

The Cost of Fuel.—It is obvious to every one that the *consumption* of fuel depends on the construction and power of the engine, the gradients of the road on which it operates, and the load which is conveyed. The *cost* of fuel really depends, in some measure, on these circumstances, but chiefly, in practice, on the *price* of wood; for in this country the price of a cord of wood is much more variable than any other element which affects the value of fuel, or the value of motive power.

The following table of the distance run by locomotive engines in different parts of the country, together with the annual aggregate expense of fuel, and the reduced expense, per mile run, will serve to exemplify this point.

TABLE of the Expense of Fuel.

Name of Road.	Year.	Distance run by engines in miles.	Expense of fuel.	Cost of fuel per mile.	Remarks.
Georgia Road,	1842	152,873	$ 6,405	4.2 cts.	
Central Road,	1842	102,145	4,810	4.7	
South Carolina Road,	1842	260,324	13,950	5.3	South'n Roads, Average 5 cts.
Portsmouth and Roanoke,	1842	96,000	4,700	4.9	
Petersburgh Road,	1842	131,160	8,200	6.2	
Baltimore and Ohio,	1843	509,765	33,547	6.6	
Baltimore and Susquehanna,	1842	128,349	8,981	7.0	
Utica and Schenectady,	1841	155,828	11,000	7.1	
Philadelphia and Columbia,	1842	261,744	22,000	8.4	Roads in Middle States, Average 9 cts.
New York and Erie,	1842	24,564	2,744	11.1	
Reading Road,	1842	198,055	19,002	9.6	
Norwich and Worcester,	1842	144,321	14,662	10.2	
Western Road,	1842	397,295	50,774	12.8	New England Roads, Average 13 cts.
Providence Road,	1842	120,000	17,548	14.6	

[NOTE.—The expense of fuel on the New York and Erie Road, includes the cost of sawing, and the loading of the tenders. The

engines on this road, as well as some of those on the Reading and Western Roads, carry very heavy freight trains.]

On inspecting this table we observe that the cost of fuel for each mile traveled by the engines, increases very uniformly as we proceed from south to north. We know, also, that the price of wood likewise increases on the route, though not precisely in the same proportion. Wood is worth, on the average, two and a half times as much in New England as it is in Georgia—but there are roads in New England on which the expenditure for fuel is from three to four times as much as it is on some of those in Georgia. This inference is not wholly attributable to variations in price, but depends, in part, on the size of the engines, and the magnitude of the trains conveyed. The engines on the southern roads, are, in general, not quite so heavy, nor so heavily loaded, as those used on several of the northern lines—a circumstance which somewhat, though not very materially, influences the result. Waiving the influence of this consideration, and regarding the engines as of nearly the same average weight on all these lines, this table will supply us at once with a correction to the formula, which we may apply when we desire to approximate more closely to the actual expenses.

The formula, for computing the aggregate annual expenses of a railroad, is based on an average cost of fuel of 9 cents per mile run.

In making the application, from year to year, we shall find that the results which it supplies will need to be modified, and that this modification will be equal to an addition of 4 cents per mile run for the New England roads, and a reduction of 4 cents per mile run for the Southern roads.*

Wages of Train Hands.—It is the practice of many companies to include the wages of enginemen, firemen, conductors, breakmen, &c. in the item of fuel and salaries; of others to combine them with oil and repairs of engines and cars. Indeed, the heterogeneous mixture of items, which are presented to the public in a lump, cannot but lead sometimes to the conclusion that it is the object of the report to conceal the simple truth. It cannot be supposed that any company mingle such dissimilar items together in their own books; and as it is really easier to copy off the items under their separate heads, than to add them together and present them in a mass, it must be supposed that the object of the condensation of matter is to prevent an intimate acquaintance with their affairs. This inference is strengthened, in my estimation, by the fact that the accounts of those companies which pursue this course, exhibit an annual, and sometimes vast, augmentation of capital. By keeping the items concealed, the public are forbidden from ascertaining what portion of the ordinary current charges go to swell the annual charge to construction, and the deception is thereby practiced longer with impunity. There are certainly some remarkable exceptions which might be named as good models for imitation. The accounts of the Georgia Road are always presented

* I propose to present, in a future number, a more accurate and general formula for the determination of the consumption of fuel.

with clearness and accuracy; and though they might be greatly improved by the addition of the net and gross tonnage, and travel conveyed one mile, they exhibit, in their present state, a much better appreciation of the importance of knowing the precise and detailed condition of their business, than is observable in the statements of other similar institutions.

The report of the Baltimore and Ohio Company, for the current year, also stands out conspicuous amidst the general confusion; and, as ought to be expected, *every item* of expenditure on that line compares advantageously with the corresponding item on any other road in the country.

The directors of the Norwich and Worcester Road, have published a table which might be made valuable, but it is actually rendered almost useless for want of the amount of the business transacted. The number of tons of goods, and the number of passengers conveyed one mile, ought to have been stated, and the different classes of wages should have been separately given. It is of little use to tell us the exact amount of expenses incurred in the transportation of freight without informing us of the amount of freight transported.

The directors of the Western Road have also produced much valuable detail; but they have failed to present the item of "services" under appropriate heads. No correct judgment can be formed of the economy of the administration of a line on which the salaries of agents and superintendents, president and engineer, train-hands and wood-cutters, clerks and ticket-men, are condensed into one total. The separation of this column—the accurate addition of the number of passengers carried one mile, and the *quantities* of each sort of fuel consumed—would render the report of this company a most valuable document. I trust that they will not be deterred from continuing this detailed exhibition of their affairs, when their road and machinery begin to manifest some of the effects of time and use.

In consequence of this mingling of items, I am unable to separate, with the desirable precision, the sum paid on many roads for wages to the engine-hands, from that paid to the conductors and breakmen. For this reason I find it convenient to include the wages of all the train hands in the item of locomotive power. This item must, accordingly, be expected to vary with the magnitude of the train, and, somewhat, with the acclivities of the gradients: heavier gradients and the larger trains requiring usually a greater number of breakmen. The variations consequent on this cause, are, however, very small; and we will come exceedingly near the truth by this formula,

$$7\tfrac{1}{2}+\frac{t}{25}$$

for the value of the wages to the train hands, in cents, for each mile traveled by the train—t standing for the average number of tons of freight in each train. The correctness of this approximation will be seen by a glance at the following table.

TABLE.

Name of Road.	Year.	Miles run.	Wages to train hands.	Wages per mile.	Remarks.
Reading Road,	1841	83,717	$ 5,785	7.0	With moderate trains.
Reading Road,	1842	198,055	17,752	9.0	With heavier trains.
Boston and Providence,	1842	132,229	10,799	8.0	Medium trains.
Baltimore and Ohio,	1843	509,765	31,161	6.1	Light trains and heavy grades.
Eastern Road,	1842	184,127	14,774	8.0	The trains on both these roads are moderate.
Georgia Road,	1842	152,873	12,666	8.3	
Petersburgh Road,	1841	131,160	14,558	11.0	The Petersburg road was worked at disadvantage in 1840
New York and Erie,	1842	24,564	2,814	11.5	and '41. The freight trains on the N. Y. & Erie road are unusually large.

The average value of wages, excepting for roads on which the trains are excessively large, may be safely and justly assumed at 8 *cents per mile run.*

Oil and Tallow for Engines.—The expense of oil is certainly a very small matter, when compared with the aggregate yearly charges against a railroad company; but it is a very important matter for every company to know exactly what this, and every other item of expense really is, and ought to be, in order to judge of the possible ameliorations of their management. On the Georgia Road, in 1840, the mere greasing of the engines amounted to more than 4 per cent. of the aggregate charges of the company. In 1842, this item was reduced down to less than 1½ per cent.

As another example of the effect of the same sort of economy in the detail—in small matters—may be adduced the curious fact, that the sum paid for oil by the Philadelphia and Baltimore Railroad Company, in 1841, amounted to $6,131, and 1842 it was reduced down to $2,151. In the year 1842 it amounted to 3⅓ cents per mile run, and in 1842 it scarcely exceeded $1\frac{1}{5}$ cents per mile run by the trains.

The expense of oil is generally included under the head, "fuel, oil, salaries, general and incidental expenses, &c.;" "fuel, oil, salaries, wages, loading merchandize, and miscellaneous expenses;" "wages, fuel, oil, &c." This method of condensing accounts is so general, that out of the reports of more than thirty railroad companies for the year 1842, now on my table, I am able to select but the three following, from which the cost of the oil consumed by the engines, can be obtained separate from other items.

TABLE.

Name of Road.	Year.	Miles run by engines.	Cost of oil for engines.	Cost per mile run.	Remarks.
Georgia Road,	1842	153,873	$1,411	.9 cts.	Cotton waste is included in the charge on the Balt. & Ohio, and believed to be included in that of the Georgia ro'd.
Baltimore and Ohio,	1843	509,765	4,399	.9	
Philadelphia and Columbia,	1842	261,744	3,104	1.2	Including oil for stationary engine.

This table would seem to justify the assumption of 9 *mills per mile run,* for the consumption of oil and cotton waste by the engine and tender alone.

There is to be found a considerable list of reports in which the aggregate consumption of oil by *engines, tenders, and cars,* may be separated from all other items. I have also some manuscript statements from which these items can be obtained. The following table exhibits the aggregate cost of oil for various lines, and the cost reduced to the mile traveled by the train.

TABLE.

Name of Road.	Year.	Miles run by trains.	Cost of oil for engines and trains.	Cost per mile run.	Remarks.
Central Road,	1842	102,145	$ 1,103	1.0	Light trains.
Reading Road,	1841	83,717	1,621	1.9	Heavier trains.
Reading Road,	1842	198,055	3,936	2.0	Still larger average trains.
South Carolina Road,	1842	260,324	2,784	1.1	
Utica and Schenectady,	1841	155,828	3,500	2.2	Not strictly accurate.
Philada. and Baltimore,	1842	177,859	2,151	1.2	Chiefly passenger trains.
Georgia Road,	1842	153,873	1,821	1.2	Trains equal the preced'g.
Norwich and Worcester,	1842	144,321	1,947	1.4	Wei't of trains unknown.
Western Road,	1842	397,295	9,215	2.3	Heavy trains.
New York and Erie,	1842	24,564	481	2.0	Heavy freight trains.
Baltimore and Ohio,	1843	509,765	7,201	1.4	Lighter trains.

The consumption of oil and tallow may be estimated, in general, at 9 mills per mile run for the engine and tender, and an additional allowance of $\frac{1}{4}$ mill for each ton net conveyed one mile.

I have also the consumption of oil and tallow for some other roads, but as these statements manifest great and censurable extravagance, and cannot be used to show the necessary expenditure on a well conducted work, I have not included them in the preceding list.

Sawing Wood, Pumping Water, and Loading Tenders.—It is not easy to collect facts which will exhibit the actual cost of the items included under the present head for many roads; but it is very easy to estimate their average value by direct calculation. We know that it is worth, on the average, about 40 cents per cord to saw the wood suitably for this purpose: and we know also that a cord of wood is sufficient to supply the consumption of the engine while

running about 40 miles. It is, therefore, worth *one cent per mile run*, to cut the wood for this object. To load the tenders, where the business is regular and great, is worth about 20 cents per cord, or *a half cent per mile run.* The cost of raising the water depends more on the conveniences afforded by the situation. If we assume the average lift at 30 feet, the labor of a man will be equal to raising about 40,000 pounds per diem. Engines usually evaporate from 300 to 400 pounds of water per mile run, which brings the cost of pumping to about the $\frac{1}{110}$ of a day's labor—or about 8 mills *per mile run.* These items make together $2\frac{1}{2}$ cents per mile run.

The result of experience for two roads is given in the following

TABLE.

Name of Road.	Year.	Miles run by engines.	Cost of sawing, loading, and pumping.	Cost per Mile.
Boston and Providence,	1842	120,000	$ 3,266	2.7
Philada. and Columbia,	1842	261,774	5,989	2.3
			Average,	$2\frac{1}{2}$ cts.

Locomotive Power.—We have now gone over the items in detail which compose the cost of locomotive power, and are, therefore, prepared to sum them up, and compare the aggregate of the averages with the amount at which it is stated in the formula, proposed for the computation of the aggregate annual expenses. These items are

	Cents.
Repairs of engines and tenders per mile run, .	7.0
Fuel, per mile run, ...	9.0
Wages of train hands, per mile run, . .	8.0
Oil for engines and tenders, per mile run, .	.9
Sawing wood, loading tenders, and pumping water, per mile run, ...	2.5
Cost of locomotive power per mile run, .	27.4

It will, of course, be recollected that this result is independent of the injury to the road, which we have considered under the usual head of "extraordinary expenses."

The only division of these expenses which is liable to material variation, is the cost of fuel, the price of which varies with the localities. I have already offered an approximate correction of this item, which may be employed for general investigations; and shall shortly take occasion to present a more accurate formula for its computation, based upon a very extensive experience.

It might seem to the general reader, that after presenting the cost of repairs of the road, engines, and cars; the value of fuel and wages of train hands; the consumption of oil, and the injury to the iron, that there would remain but little more to adduce in the premises; but I have yet a very important division of the subject to discuss, which is much too frequently overlooked in investigations of this character.

There are other extraordinary expenses, and certain contingencies which go far to swell the annual charges on every line—without any exception in behalf of the most favorably situated, or of those which are most economically administered.

I proposed, in a former article, to offer an estimate of the probable expenses for the present year, on a railroad in active operation, which is now the object of much attention and interest, in order to exhibit an application of the formula in anticipation of the publication of the company's next report. I take the Philadelphia and Reading Railroad for this purpose; and assume that it will this year give transit to 250,000 tons of freight, and 40,000 passengers. The application of the formula to this work—making proper allowances for its gradients and drawbacks, the facilities for unloading, and having due respect to its age—will produce, for the aggregate expenses, the sum of $265,000.

This estimate, of course, refers only to the apparent expenses, and includes no part of those reserved charges—such as the wear of the iron—which are usually denominated "extraordinary expenses," because they are not generally of annual recurrence. The durability of iron rails I assume at about 800,000 tons—while they are estimated by the enthusiastic friends of the road, at 12,500,000 tons, and sometimes at infinity. Where such immense differences exist, time must decide the question. I trust that time may not show that I even am too sanguine, and expect more from the railroad system than it is capable of rendering.

(To be continued.)

Mr. Vignoles' Lectures on Civil Engineering, at the London University College.

(Continued from vol. vi, p. 394.)

Second Course—Lecture xvii.

Before proceeding to a summary of the second course, Mr. Vignoles observed that there was a material point connected with the subject which had not been sufficiently discussed, viz., the motive power to be employed; on this greatly depended the principles on which a line of railway should be laid out, the end and object being to convey the greatest extent of traffic at the least cost: this cost was compounded, first, of the interest of the capital expended, which should be considered a constant charge; and second, of the periodical working expenses—the work to be done being summed up in the general expression of "overcoming all obstacles to facility of motion." What are these obstacles? They might be divided into two great heads—Gravity and Friction. 1st. Gravity is a natural cause existing under all circumstances, and, affecting lines deviating from the horizontal, in direct proportion to the sine of the angle of inclination. Engineers, therefore, have considered that the first principle of laying out roads, should be (under limits) to approximate as nearly as possible to the horizontal, in order to exclude one of the great causes of obstacle; since, with maximum loads, the retardation arising from gravity is most felt. When such could not be effected, then to dis-

tribute the total rise (or effect of gravity) along the easiest ratio of slope. But, in practice, the occurrence of maximum loads, in ordinary passengers and merchandize traffic, forms the exception, instead of constituting the rule, and it is only when a regular and constant heavy trade is to be anticipated, that horizontal communications should be insisted on. 2nd. Friction, is a physical cause, varying according to the perfection of the road, and of the vehicles moving on it. In the practical working of a railway, however, so many expenses arise under the heads of "conducting traffic, management, &c.," common to most lines, whatever the gradient, that they tend to make the cost of overcoming friction, and even gravity, (particularly with the ordinary light loads) but a small fraction of the total charges. Comparing the amount of obstacles on a railway with that on the ordinary road (where the friction, meaning thereby axletree friction, and surface resistance, may be called sixteen to twenty times greater than on a railway,) and assuming the inclination on railway and road to be the same, the general result is that the perfection of the railway surface moved over, and the improvement of carriages, or rather that of their wheels and axles, cause the effect of gravity to be felt in the most sensible degree on railways; while the imperfection of the road causes it to be comparatively scarcely appreciated. Hence with the wretched surfaces of the old roads, and the clumsy wheels of our primitive vehicles, the hills seem to have scarcely added to the obstacles to be overcome. As the road surfaces and carriages improved, and increased speed, and heavier loads were introduced, the necessity for the greater perfection of the ordinary road became apparent, and the remedy was applied in various degrees during the last 100 years until it was completed as far as possible, in the extensive improvements by Telford and Macneill on our great highways. But in carrying out this principle on railways we have run into the opposite extreme. We should first take in one sum the retarding causes of gravity and friction, viz., the friction, being constant, or nearly so, putting aside the resistance of the air, at high velocities, vary only in the perfection of the wheel axles, and in the mode of lubricating, (the surface resistance on railways being, practically speaking, nothing,) and the maximum gradient, or rather the gravity due to it: their sum will be the constant divisor for the motive power, of whatever description that motive power might be; and, in considering the latter point, it must be the distribution of the traffic, or what may be called the average hourly load throughout the year, which is to determine the question. In many instances, in this point of view, it would probably often be found most economical to use animal power, (as is done on the Edinburgh and Dalkeith Railway,) were not velocity required—which, on railways, enters so materially into the calculation, that mechanical power in some shape becomes necessary; and this divides itself into stationary power, or when the mechanical means are fixed, and locomotive power, or when the machine travels along with the load. There are two serious difficulties connected with the latter system; first, a great addition to the load, equivalent, on the average, to doubling it; and next, that the fulcrum through

which the motive power must be transmitted—that is, the rail on which the locomotive driving wheel impinges—is greatly affected by atmospheric causes, occasioning great variation in the adhesion, and consequent uncertainty from slipping of the wheels, so that, as explained in a former lecture, the load after a locomotive engine is really limited by its adhesive power, and not, as might at first be supposed, either by the cylinder power, or boiler power. Considered abstractedly, stationary power is cheaper, and always would be so if the traffic were certain and regular, with maximum loads and very moderate speed, even with the present obstacles of ropes, sheaves, and all their contingent complicated apparatus; but at high speed, with a great length of rope, the experience of the working of the Blackwall Railway has shown that for passenger trains only, there was, compared with the most expensively worked lines on the locomotive system, to say the least, no economy in the motive power, though other conveniences arising from the peculiar arrangements on that line, were, perhaps, in this special case, more than an equivalent. A most serious obstacle to stationary power, was the necessity of absolutely stopping, and disengaging and refixing the trains at each station, which stations could not be conveniently, and certainly not economically, placed further apart than three, or five miles, for it could readily be proved, than on a continued distance of six or seven miles of railway worked by a rope, the power of the largest engine that could well be erected, would be absorbed in moving the rope only. The Professor then went largely into a consideration of applying stationary engines as the motive power in working inclined planes under a variety of circumstances, and recommended to the students to consult the valuable work of Mr. Nicholas Wood on this subject, and indeed on all the details of railway working, of which, particularly in the third edition, there was most of the latest information. In many situations, however, where water power could be obtained, the stationary rope and pulley system might be advantageously introduced. Gravity became the motive power, on what where called self-acting inclined planes; that is, when the gravity of a descending train of laden carriages brought up a train of others empty, or partially laden; or where skeleton wagons, or water tanks on wheels, could be used as artificial counterbalancing weights in either direction alternately; the circumstances under which self-acting inclined planes could be properly introduced were rare. Mr. Vignoles then gave a clear account of various modes of working self-acting inclined planes; among these was described a curious and interesting one near the great limestone quarries in North Staffordshire; another on the St. Helen's and Runcorn Gap Railway, which he had himself put up, and also the planes for the Great Portage Railway, across the Allegheny Mountains, in the United States of America. Stationary power might also be used to a greater extent on the atmospheric system, whereby, to speak metaphorically, a rope of air was substituted for a rope of hemp, or wire, and where no pullies were required, nor any necessary stoppage at the intermediate engines, where only the carriages had to be moved, and where nearly the whole dynamic force generated was

made available for motive power. This system had already been explained to the class, and practically illustrated on a railway thus worked, and need not be further alluded to. The Professor was preparing for publication a separate lecture "On the Atmospheric Railway System," to be illustrated with plates, and tables, and appendices, in which that interesting subject would be fully gone into, and all the mathematical and philosophical investigations given, with estimates of the cost of such railways under various circumstances of traffic and gradient; fully enabling the value of the principle, as a motive power, to be appreciated. Although modern practice had almost discarded the use of animal power from railways, it might be proper to refer cursorily to it. A horse seems adapted to drag vehicles, from the mode in which he adjusts his muscular action, so as to throw the greatest effect on the line of draft; in making an effort to draw a carriage, the body of the animal is bent forward, throwing upon the latter the part of its weight necessary to overcome the resistance, the muscular force of the legs being employed in keeping up his traction, and moving the body onward; the effort of the animal being resolvable into these two parts, viz., the action on the load, and that required to move itself by. It may be gathered from writers on this subject, that the force a horse is capable of exerting, is that equal to about one-seventh, or one-eighth part of his own weight: or that, on an ascent of one in seven, or one in eight, the exertion required to overcome his own gravity, is a force equal to that he is able to exert on a load on a level plane. Taking the average weight of a horse, and considering that he is capable of occasionally exerting great extra power on the load, still it seems to be satisfactorily ascertained, that nearly seven parts out of eight of the muscular power of a horse is required to drag his own weight forward, leaving, of course, only one part applicable to the load. But the criterion of a horse's power, in practice, is not the occasional effort of which the animal is capable at a dead pull, or for a short period: we must estimate his strength by what he can do daily, and day after day for a long period, and without breaking him down prematurely. If a horse is to travel at the rate of 10 miles an hour, his power of pulling is greatly diminished, and he can work only an hour or so in the day: at two miles an hour he may give out a power of 150 lbs. on the load: at 10 miles he has scarcely 35 lbs. to spare, and at 12 miles an hour, he can seldom be expected to do more than move himself. This was on the average of horses—all beyond were exceptions. Thus, the application of horses to railways, as the motive power, was very limited; and in laying out lines where they are to be used, to full effect, gravity should be arranged to be always with the load, or, at least, not against it; the rate of traveling only 2 or 2½ miles per hour, and the traffic uniform. Mr. Vignoles proceeded to an interesting comparison between locomotive and stationary power up inclined planes, taking the inclination of 1 in 50 as a maximum, and showed that *when the traffic was small, and the loads consequently comparatively light, and the daily number of trains not great, locomotive engines*, as the motive power, (taking into consideration all circumstances of first cost, and working

expenses, particularly the latter, of which the locomotive power was but a small part,) *would not be so expensive as stationary engines*, while they would be certainly more convenient; and that, with all the best modern improvements in the locomotive engines, the system of working with large cylinders, using the steam expansively on the level, and falling parts of the railway, improved boilers, &c., *planes of* 1 *in* 50 *might be practically worked:* the only material drawback being occasional slipping of the wheels on the ascent, and the necessity of great caution and careful application of the brakes on descents; but on the whole, the balance, *under the above circumstances*, was much in favor of the locomotive system. The Professor then entered into a very long and minute comparison of the present system of working the Blackwall Railway by stationary engines, with ropes and pullies, with what would be the case if the motive power were locomotive engines—and by tables, showed that while the working of the Blackwall Railway ($3\frac{1}{2}$ miles) on the stationary system, was costing about *seventy-two pence* per mile per train, the cost of working the Greenwich Railway ($3\frac{3}{4}$ miles) was only about *forty pence:* but Mr. Vignoles admitted, that by the former, great accommodation to the public was afforded by the numerous intermediate stations, while on the latter there was only one stoppage. In concluding the general comparison between the two principles of mechanical motive power, the Professor observed, that on the locomotive system, a minimum of power need only be provided in the first instance, and the number of engines might be increased gradually as the traffic required, which was a great consideration when the first expenditure of capital had to be kept down to the very lowest terms, at all future risks. On the stationary system, provision had to be made, from the outset, for the maximum anticipated trade, which, of course, increased the first outlay on the railway establishment, and depended on the ultimate economy of future working to make up the difference. Having concluded the notice of various descriptions of *motive power* employed on railways, of which the preceding is but a mere outline, some general remarks were made on the principles of laying out railways, in reference to the several systems respectively.

In a concluding general summary, Mr. Vignoles observed, that in his first course, at the latter end of 1841, he had fully considered the practical rules for earthwork and constructions:—these were not peculiar to railways; the theory and practice of bridge building, applied to all internal communication, and would be most conveniently considered in a separate illustrated course, but he wished to recall to the class generally, that in proceeding to lay out railways, in the first instance, the engineer ought to enter much more deliberately into those previous inquiries, so absolutely necessary, than had hitherto been done. A system of applying the same general rule of perfect gradients alike to lines, of the least as well as the greatest traffic, had too much prevailed, and until more rational ideas were substituted, the public would shrink from embarking in enterprizes subject to all the contingencies of extra cost beyond estimates, which had characterized almost every railway in this country. *The earthwork and its*

consequences, regulated the cost, particularly as regarded contingencies, and the utmost consideration should be bestowed as to how far it was justifiable to encounter the expense of these operations. The average cost of earthwork, and all consequent works of art, &c., on the English railways was nearly £15,000 per mile, or about 50 per cent. of the whole capital expenditure. Mr. Vignoles was decidedly of opinion that in *all future lines in this country, and particularly on the continent,* the corresponding outlay *ought not to exceed* £5000 *per mile,* and that beyond that sum perfection of gradient would be bought too dearly. In reference to the *gauge* of railways, Mr. Vignoles stated, distinctly, that theoretical investigations, and practical results, led him to consider a six foot gauge the best; but the present 4¾ foot gauge was certainly rather cheaper. In respect of *curves,* he observed, that they were much less disadvantageous than had been first supposed: that a half mile radius was now everywhere admitted; and that he himself did not hesitate to adopt a quarter mile radius whenever expense could be materially saved; and if the atmospheric system of motive power should be found to succeed on a large scale, the curves might, on lines thus worked, be safely made still sharper. In regard to the systems of constructing the *upper works,* he had, in a recent lecture, entered so fully into the comparison, that he need only now say, that if the expensive and complicated system of heavy rails and chairs, and cross sleepers, were preferred by engineers, then the ingenious improvements of Mr. May, of Ipswich, in chairs and fastenings, applied by Mr. Cubitt on the South Eastern (Dover) Railway, with great care in laying, draining, and ballasting, made *that system* perfect and complete. The Professor, however, decidedly gave the preference to the less costly, and the more simple system of lighter rails, without chairs, laid on continuous longitudinal balks of timber of sufficient scantling, and fastened on Evans' principle, modified in the manner shown by the models exhibited to the class; and several engineers were adopting this opinion. On the continent of Europe, where iron was dear, and timber cheap and abundant, Mr. Vignoles calculated *a saving of full* £2000 *per mile of double road would accrue from the adoption of the latter system*—which offered a vast national economy. In reference to the subject of working drawings, plans, and sections, the Professor reminded the class of the importance he attached to having all such previously made out on a large scale, that the cubic quantities might be accurately obtained, and the just prices considered; and thus, in proceeding to make the estimates, nothing would be left to conjecture, and as little as possible left to be afterwards altered. The period of time for the execution of the works should be extended as far as consistently could be done. The two great sources of the extra expenditure on railways had been, the extreme haste with which the works had been pushed on, and the changes of every kind from the original designs. These points being all carefully considered, *even before the plan was brought before the public in general,* the estimates might be better depended on. Mr. Vignoles then went through all the great items of expendi-

ture generally arising on first construction, and explained how the accounts of measurements should be made out, and kept under very distinct general heads, subdivided into minor items, from the purchase of the land to the last finish to the stations, and the entire fitting up and furnishing of the carrying establishments. Sufficient experience had been attained in all these matters to enable the engineer, in future, if the above rules were faithfully followed out, to place himself beyond all chance of reproach for making erroneous estimates. In conclusion, the Professor observed, that he had selected *railways* at the request of the class, as the theme for the course just concluded; but although so much consideration had been given to the subject, he had only been able to touch in a very general way upon the chief points; yet it was to be hoped a sufficient idea had been given of the principles of construction, and of their general application, to create an interest in their minds. Should any of the students hereafter be employed to execute a railway, he trusted they would recollect these lectures with advantage, while they would also probably better understand and appreciate them; at the same time, he must not neglect to impress upon them, that it was not at the college, in the lecture room, or even in the office of an engineer, that all the duties and knowledge necessary could be taught; the young aspirant must pass much time in the workshop; indeed, he must become a workman, and acquire the use and skill in the handling of tools, and the erection of mechanism of every kind—and passing to the actual works, ought to learn to be able to direct personally the labor of the mason, the carpenter, and the smith. "Above all," said Mr. Vignoles, "the student in engineering must carry into life with him the constant remembrance of what I have so repeatedly enforced, that the reputation of an engineer in this country is based upon the success of his works, of his mechanism, and of all the efforts of his mind and hand, in respect to, and in proportion to their being productive of commercial and beneficial results, to those who, at his suggestion, may undertake to provide the necessary funds; and he should consider how this result can be best obtained, rather than study the splendor of his undertakings. It is for the architect to attend to the decorative and the beautiful; it is sufficient for the engineer to study proportions, and rely on the simple grandeur of his works as a whole. It is related that Napoleon once observed to the celebrated Carnot, "*Lés ingenieurs doivent toujours avoir des idées magnifiques;*" this is true as to their first conceptions, but in the realization, they must be sobered down by the rules of economy and judgment. After the first burst of talent, after image and form has been given by the hand to the bright idea emanating from the brain, let it be brought down to practical application only after a strict inquiry into the cost. Remember what I quoted on a former occasion, when contrasting the two celebaated light-houses, the *Eddystone*, and the *Cordoun*—no unfit emblem of the two celebrated engineers who erected them, may I venture to add, of their respective nations—remember, I say, "*'tis use alone that sanctifies expense.*"

Results of the application of Horse-power to raising Water from the working shafts of Saltwood Tunnel, on the South-eastern Railway, in 1842. By Frederick William Simms, Esq., M. Inst. Civil Eng.

This tunnel is driven in the middle bed of the lower green sand, between which and the surface of the ground is interposed only the upper bed of the same stratum; but in sinking the eleven shafts for the work, it was found that at the level of the top of the tunnel, the ground assumed the character of a quicksand, saturated with water, in such quantity that it could not be reduced by manual labor. Under these circumstances horse gins were erected for drawing the water by barrels, containing one hundred gallons each, weighing when full about 1310 lbs.

The engineer's intention was to drive simultaneously from these shafts, in the direction of the tunnel, an adit, or heading, to carry off the water; but the earth, which was sand mixed with fine particles of blue clay, was so filled with water as to become a mass of semi-fluid mud, great exertions were, therefore, necessary to overcome the water without erecting pumps. At first this was accomplished by making each horse work for 12 hours, and then for 8 hours per day, allowing one hour for food and rest; as the water increased it became necessary to work night and day, and the time of each horse's working was reduced generally to 6 hours, and sometimes to 3 hours. As all the horses were hired at the rate of seven shillings per day, the author, who had the direction of the works, ordered a daily register to be kept of the actual work done by each horse, for the double purpose of ascertaining whether they all performed their duty, and also hoping to collect a body of facts relative to horse-power which might be useful hereafter. This detailed register, which was kept by Mr. P. N. Brockedon, is appended to the communication.

The author gives as a proposition, "that the proper estimate of horse-power, would be that which measures the weight that a horse would draw up out of a well; the animal acting by a horizontal line of attraction turned into the vertical direction by a simple pulley, whose friction should be reduced as much as possible." He states that the manner in which the work was performed necessarily approached very nearly to these conditions; and after giving the principal dimensions of the horse gins, he analyzes each set of experiments, and, by taking the mean of those against which no objections could be urged, he arrives at the following results:

The power of a horse working for		8 hours	=23,412 lbs.		raised 1 foot high pr. min.
Do.	do.	6 "	=24,360	"	do.
Do.	do.	4½ "	=27,056	"	do.
Do.	do.	3 "	=32,943	"	do.

Of these results he thinks the experiments for 6 hours, and for 3 hours, alone, should be adopted as practical guides, all the others being in some degree objectionable.

As a means of comparison, the following table of estimates of horse-power is given:—

Name.	Pounds raised 1 foot high in a minute.	Hours of work.	Authority.
Boulton and Watt,	33,000	8	Robison's Mech. Phil., vol. ii. p. 145.
Tredgold,	27,500	8	Tredgold on Railroads, p. 69.
Desagulier,	44,000	8	Dr. Gregory's Mathematics for Practical Men. p. 183.
Ditto,	27,500	Not stated.	
Sauveur,	34,020	8	
Moore, for Society of Arts,	21,120	Not stated.	
Smeaton,	22,000	Not stated.	

These are much higher results than the average of his experiments, and would more nearly accord with the extremes obtained by him; but under such excessive fatigue the horses were speedily exhausted, and died rapidly. Nearly one hundred horses were employed, they were of good quality, their average height was 15 hands ¼ inch, and their weight about 10½ cwt., and they cost from 20*l.* to 40*l.* each. They had as much corn as they could eat, and were well attended to.

The total quantity of work done by the horses, and its costs, was as under:

		Tons.
Registered quantity of water drawn 104 ft., the average height, 28,220,800 gallons,	=	128,505
Registered quantity of earth 3,500 yards, 1 ton 6 cwt. per yard,	=	4,550
Total weight drawn to the surface		133,055

	£	s.	d.
Total cost of horse labor, including a boy to drive each horse,	1,585	15	3

Or, 2.85 pence per ton, the average height of 104 feet.

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Franklin Institute.

Supplementary Report

Of the Committee on the Thirteenth Exhibition of American Manufactures, held in Philadelphia from the 17*th to the* 28*th of October,* 1843, *by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mehanic Arts.*

The following awards are made made in conformity with the revised reports of the judges, on the several articles named:

II.—*Woolen Goods.*

Nos. 145 to 147, embossed table covers, by Duncan & Cunningham,

Belleville, N. J., deposited by D. S. Brown & Co., considered by the judges to reflect great credit on the manufacturers—a silver medal.

No. 148, embroidered woolen Thibet shawls, exhibiting great improvement in this article, made by Duncan & Cunningham, Belleville, N. J., and deposited by D. S. Brown & Co.—a silver medal.

IX.—*Saddlery, Harness, and Trunks.*

No. 358, harness, by William N. Lacey, recommended by the judges in a supplementary report for the award of a medal—a silver medal.

XIII.—*Musical Instruments.*

No. 1201, by Henry Corrie, deposited by James Cox, an organ, in regard to which the judges say that "the arrangement of the stops and pedals, is, in some respects, novel and allows of every possible variety of combination, and the stop denominated the Euphonia, may yet be regarded as new"—a certificate of honorable mention.

XXIV.—*Leather and Morocco.*

No. 390, by Taylor & Kinsey, of Philadelphia, Tampico French leather, recommended for the award in the supplementary report of the judges—a silver medal.

No. 399, by Scattergood & Bousted, Russet bridle leather, recommended for the award in a supplementary report of the judges—a silver medal.

No. 318, by Charles B. Williams, slaughter sole leather, recommended for the award in a supplementary report of the judges—a silver medal.

XXVI —*Chemicals.*

No. 320, by Mrs. Mary West, for the excellence of the jeweler's rouge, prepared by her—a certificate of honorable mention.

XXXIII.—*Paints and Colors.*

No. 309, by Wetherill & Brothers, the smaller sample of white lead, which may, in the opinion of the judges, supersede the Kremnitz white—a certificate of honorable mention.

Extracts from the Reports of the Judges appointed to examine the Articles offered at the Thirteenth Exhibition of American Manufactures.

Report on Cotton Goods.

The Committee on Cotton Goods have carefully examined the several articles submitted to their inspection by the Franklin Institute, and respectfully report as follows:

No. 2, fine bleached longcloth, manufactured by Benjamin Marshall, New York Mills, Whitestown, N. Y., is a very superior article, stout, fine, even, and compact, and is believed to be the best ever made in the United States, rivaling the famed British longcloth—it merits special notice. A sample of the unbleached cloth is also exhibited, differing from the above only in color.

No. 19, Preston longcloth, manufactured by the Lonsdale Company, Providence, R. I., an excellent, well made shirting, which would be more highly esteemed in the absence of the above, which casts a shade over all others. There are also good samples of bleached shirtings and sheetings from the Bartlett, Phœnix, and Steam Cotton Manufacturing Companies, and brown sheetings from the Stoneville Manufacturing Company.

No. 20 Earlston ginghams, manufactured by R. Beath, a fair article, the finish improved upon former specimens.

No. 40, ginghams, manufactured by Hood Simpson, Philadelphia, a fair imitation of the imported Manchester ginghams.

No. 47, imitation linen diaper, manufactured by John Elliott, Philadelphia, a well made article fairly representing what the title purports.

Bleached Canton flannel, manufactured by S. Sheppard & Sons, well made, strong, substantial, and smooth, and altogether a serviceable article. A good specimen of similar goods is also exhibited from the Amoskeag Manufacturing Company.

Tickings, of fair quality, from the factories of James Campbell, and Robert Whitaker.

Tapes, cotton cords, and laces, manufactured by Thomas Brown, Blockley; Fletcher & Bros, Providence, R. I.; I. Learch, Philadelphia; and Ezra I. Cady, Centreville, R. I., are creditable specimens. The striped tapes, by Thomas Brown, are noticed as a new article, and very good.

Turkey red cotton yarn, from James Wright, was referred to the Committee on Exhibitions, subject to their decision upon the expediency of submitting it to chemical tests.*

The display of Printed Cottons is unusually large, and brilliantly illustrates the great perfection attained in this branch of manufactures.

The American, and Hamilton Print Works, and Joseph Ripka, exhibit favorable specimens of their skill, but those presented by J. Dunnell & Co., Pawtucket, R. I., A. Robeson, Fall River, Benj. Cozzens, Providence, R. I., and Perkins & Wendall, Bustleton, Pennsylvania, are of surpassing beauty, combining elegance of design, brilliancy of coloring, and accuracy of execution in an extraordinary degree. Of these competitors we are unable to select one as pre-eminently meritorious, where all are so highly commendable.

Printed furniture chintzes from A. Robeson, Benj. Marshall, and American Print Works, and window shades from Hamilton Print Works, are in good taste and well executed.

Very handsome and chaste styles of printed lawns are exhibited from A. Robeson, Fall River.

Perkins & Wendall have produced a variety of beautiful styles in lawns, balzorines, and mousselines de laine, evincing taste and skill of no common order, well deserving a premium.

This is a new branch of printing here, in which success is no longer doubtful. Your committee are informed that extensive preparations

* Those appropriate tests were applied by Professor Booth, and Mr. Boyè, and on their report a certificate of honorary mention was awarded.

are making in a factory for spinning very fine yarns, and weaving the lighter lawns and muslins. All who have viewed the rich array of Printed Goods must be impressed with the extraordinary advancement in this department.

With the exception of Printed Goods, the specimens are not so numerous as upon some former occasions; this may arise from the fact of many of the staples having attained so great perfection, that there is scarcely room for improvement. This exhibition, as well as former ones, has also been deprived of some samples of new fabrics, owing to the reasonable unwillingness, on the part of manufacturers, to expose to view samples of new goods in advance of the selling season.

The Cotton manufactures of the United States are constantly growing in importance; beside supplying the largest portion of clothing required for home consumption, large quantities are annually shipped to foreign countries: they are in demand in Mexico, South America, California, &c., and recently a market has been opened for them in China. If the Institute has, in any degree, by encouragement, assisted in advancing this branch of manufactures, there is reason to rejoice, and to continue efforts in its favor.

Report on Iron and Steel.

The Committee of Judges of the Iron and Steel exhibited at the Exhibition of American Manufactures, now held in the Philadelphia Museum, by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, respectfully report:

That the samples submitted to their inspection were generally highly creditable to the manufacturers, and afford gratifying proofs of the progress made in the manufacture of Iron and Steel, those essential articles upon which depend almost all other manufactures.

A certificate of honorary mention is recommended to be given to Morris & Jones, for the very handsome display of iron and steel contributed by them, from the iron ore to the finished bar.

The specimens of rolled iron, both flat and round, from the Colemanville Iron Works were of excellent quality.

Some of the hammered iron from William Dowlin, of Mary Ann Forge, Chester county, was very superior.

Very good samples of iron from the Tredegar Iron Works, at Richmond, Virginia, deposited by James S. Spencer, jr., came too late for competition.

Bundles of nail rods from the Colemanville Works, deposited by Morris & Jones; from Valentine & Thomas, deposited by Isaac Miller; and from the Howard Iron Works, deposited by E. J. Etting & Brother, were all excellent, and so nearly alike in quality as to make it difficult to discriminate between them.

Specimens of imitation Russia sheet-iron, by James Wood & Sons, for which a silver medal was deservedly awarded last year, are fully equal to those then exhibited.

Samples of sheet-iron, deposited by T. S. Speakman, and intended to imitate the Russian, were examined by the committee, but Mr. Speakman has not yet succeeded in giving the peculiar glaze characteristic of the article.

Some common sheet-iron from Colemanville, is very well rolled, and has a smooth surface.

A certificate of honorary mention is recommended to be given to J. L. Mott, of New York, for a cast-iron bathing tub in one piece, being of good form and size, and weighing only 268 lbs. This is a new article to the committee, and they think it might be made still lighter by a proper mixture of pig iron, with the use of a portion of anthracite iron, which has been so successfully used for hollow ware.

The specimens of hollow ware and other castings, by Savery & Co., of Philadelphia, are so admirable, that the judges recommend the award of a silver medal to those gentlemen for the excellence of their articles, unless they have received one from the Institute at some former exhibition.

The steel converted at Colemanville Iron Works, deposited by Morris & Jones, is a pretty fair sample of American blistered steel, and the spring steel from the same place, has a good appearance, and is very well rolled.

Blistered steel by Broadmeadow, from Balliott's iron, is tolerably good.

Samples of steel, said to be cast-steel, from Broadmeadow & Stanton, of Manayunk, are better than the blistered steel, but not equal to good English cast-steel.

The blistered steel converted by John Robbins, jr., of Kensington, from Swedes' iron, is a very superior article. That by him from American iron, intended for saw-plates, appears to be good, but the committee have not had time to test it. For the general excellence of Mr. Robbins' steel, the committee recommend him a certificate of honorary mention.

A sheet of boiler iron 11 feet 4 inches by 26 inches, by S. Hatfield, deposited by William F. Potts, is very smoothly rolled, as is also a large sheet deposited by Morris & Jones.

Report on Umbrellas.

The Committee appointed to examine the Umbrellas in your present exhibition, beg to report that they have carefully examined them, and find—

No. 42, to be a case of highly finished handles and knobs, tastefully designed, and well executed.

Nos. 203, 247, and 268, are an excellent assortment of well finished umbrellas, parasols, and sun shades, and are a great credit to the manufactories of this city.

Your committee have peculiar pleasure in recommending these to notice, because they have reason to know that they were not prepared for exhibition, and they are not, therefore, proofs of how high a state of perfection these could be carried; but they are proofs of the

excellence of the stocks from whence they were selected. Your committee would more particularly recommend to notice the parasols and sun shades manufactured by Messrs. W. & W. H. Richardson, of an entirely new fashion, and also those manufactured by Mr. W. A. Drown, all of which are proofs of beautiful workmanship.

Your committee would be pleased if they were at liberty to refer to two cards of sun shades, manufactured by Messrs. Sleeper & Brothers, of American silk only. When this article shall be fully introduced, we anticipate for it a large demand for this purpose.

Report on Lamps and Gas Fixtures.

The Committee on Lamps and Gas Fixtures report, that the display in this department, although not so extensive as on some former occasions, is certainly unsurpassed in point of beauty and excellence of the specimens. Messrs. Cornelius & Co., to whose enterprize is due the greater part of the magnificent display of Lamps and Gas Fittings, seem to have made a successful effort to combine increased perfection of shape and finish with a very considerable reduction of cost to the purchaser. We would notice particularly the richly ornamented gas pendants and chandeliers finished in Ormoulu, the workmanship of which is exceedingly beautiful, the color faultless, and the whole effect such as may satisfy the most fastidious taste. The silver chandelier and candelabra are remarkably chaste, and, in combination with the judicious arrangement of the glass ornaments, produce a very brilliant effect. The silver coating on these articles is produced by the speedy operation of the galvanotype, and appears to be more perfect than is generally produced by that recent art. The humbler solar and lard lamps deserve more than the passing notice which they receive at the hands of the committee, and will, no doubt, serve to gratify the good taste, and aid the vision of a far greater number of our fellow citizens, than will the more showy and expensive chandeliers. For their rich display, the committee cannot hesitate to recommend the award of a silver medal to Messrs. Cornelius & Co.

They would also recommend the award of honorable mention to E. Whelan, for No. 728, a pair of silvered candelabra, which are deemed creditable to his skill. To J. S. Gold, for an assortment of camphine lamps and chandeliers, got up with judgment and good taste. To Ellis S. Archer, for a variety of lard lamps. To Filley & Kisterbock, for a display of similar useful articles.

Report on Models and Machinery.

Whilst the judges have occasion to regret, that the display of Models and Machinery falls short of former exhibitions, they can, nevertheless, trace amongst the one hundred and fifty specimens, which are now deposited, abundant evidence that the hand of the American mechanic has not lost its art, and that it needs but suitable occasions

to call forth a superior degree of genius in design, and skill in execution.

No. 1538, a two oared skiff, built by James & Joseph Albertson, Beach street, Kensington, with an oak frame, cedar planking, copper fastened throughout, and having the rowlocks faced with brass; is an elegant piece of workmanship, and deserves the first place in this department. For this we recommend the award of a silver medal.

No. 1631, copying presses, of excellent workmanship, by Charles Evans, of Philadelphia, deserves a silver medal.

No. 1503, a horizontal steam engine, built by James Brooks, of Frankford, acting as the motor of the working models in the lower saloon, appears to be a good and serviceable piece of work, and deserves a certificate of honorable mention.

No. 1504, a locomotive boiler, built by J. W. & J. F. Starr, of Kensington, which is now employed to supply steam to the preceding engine, is an excellent specimen of work, and fully sustains the high reputation of that well known firm; it deserves a certificate of honorable mention.

No. 1516, a slide rest, by William Bien, of Philadelphia, is well made, and deserves a certificate of honorable mention.

No. 1530, a box of shuttles, by E. S. & R. O. Tripp, of Trenton, N. J., are very well made, and deserve a certificate of honorable mention.

No. 1531, four platform scales, made by J. D. Dale, of Lansingburg, N. Y., appear to be of a very serviceable character, and deserve a certificate of honorable mention.

No. 1570, an ice apparatus, which, by distributing water upon a plane surface in thin jets, appears to be well calculated to make ice of a considerable thickness, at temperatures but little below the freezing point; it deserves a certificate of honorable mention.

No. 1577, a log brace for saw-mills, by Mr. Cushwa, of Washington county, Md., is designed to support the middle of a log near the saw, by means of a roller and lever; this seems to be a useful contrivance; it supplies a want often felt in cutting long timber, and deserves a certificate of honorable mention.

No. 1582, an apparatus for corking bottles of mineral water, is a machine ingeniously devised, by D. C. Palmer, to cork up gaseous waters without loss of gas; and it deserves a certificate of honorable mention, both for its design and workmanship.

No. 1583, a sub-soil plough, by D. O. Prouty, dealer in agricultural implements, is a good specimen of this new tool, which is producing such admirable effects in England, when properly applied to the tillage of soils; and we think it deserving of a certificate of honorable mention.

No. 1596, an abridged set of stencil plates, by George W. Duncan, of Philadelphia, in which, by a judicious arrangement of straight and curved slits, representing the elementary lines which form letters, and numbers, the whole alphabet, and all the digits are produced with facility; this deserves a certificate of honorable mention.

No. 1598, a small lathe, by William M. Davis, machinist, Philadelphia, of which the work is of a fair character, and deserves a certificate of honorable mention.

No. 1617, fire proof chest, water coolers and filters, by David Evans, of Philadelphia, the fire proof having an escutcheon that masks the keyhole in a manner so ingenious and effectual, as to make it very difficult for any one not possessed of the secret, to effect an entrance. All the articles exhibited by Mr. Evans, are creditably made, and deserve a certificate of honorable mention.

No. 1618, hatters' heating irons, by John McCoun, are good specimens of work, and deserve a certificate of honorable mention.

No. 1619, three bricks, made by George Snyder, are very smooth, well shaped, and dense; they seem to be machine made, and deserve a certificate of honorable mention.

No. 1634, several shuttles, for looms, by Ellis Jackson, of Philadelphia, are very well made, and deserve a certificate of honorable mention.

No. 1640, a power loom shuttle, by Jacob Senneff, is a neat piece of workmanship, and deserves a certificate of honorable mention.

No. 1654, a blacksmith's bellows, by S. W. Metz, of Philadelphia, is very well made; it has a new mode of inserting the tuyere pipe, which appears to be a real improvement, and deserves a certificate of honorable mention.

No. 1661, Laubauch's patent blacksmith's tuyere, deposited by John Murphy, of Philadelphia, furnishes an efficient blast from the bottom of the fire; it has been very favorably reported upon by the Committee on Science and the Arts, and well deserve a certificate of honorable mention.

No. 1665, a model of a hipped roof slated, by Wm. Elliott, blue slater, of Francisville, in which plane, diamond, spade, and scale slating, are very neatly executed upon the four pitches of the model roof; these several varieties, with sufficient fineness of finish, give indications of being perfectly weather proof, and well deserve a certificate of honorable mention.

No. 1689, a small steam engine, by Greer, Amer & Newell, of Philadelphia, made upon the plan long since used by Mr. Greer, of causing the supply pump to form the piston guide, is a very good and substantial piece of work, which has all the requisites of a serviceable engine, without any extraneous display. This machine well deserves a certificate of honorable mention, if not a silver medal.

No. 1702, a machine for cutting tenons, by Mahlon Gregg, of Philadelphia, is well made, appears to be efficient, and deserves a certificate of honorable mention.

No. 1715, a slide lathe rest, by J. H. Schrader, Philada., is made with very great nicety; it possesses all the requisites of this important appendage to the lathe, and, in addition, has regulating screws to give it the proper direction in conical and angular tenoning. This well deserves a certificate of honorable mention.

A number of models of locomotive and other steam engines, were before us, in which we could trace such disproportion amongst the

parts, and such defects in plan, that if it were not for the fact, that their errors are generally so glaring, we could wish them dismissed from the exhibition, but which, as it is, will but form exemplars, *not to be imitated* by the young mechanic.

Stillman & Co., of the Novelty Works, New York, exhibit a small horizontal steam engine, of which the workmanship is fair, and some of the parts of which are very well arranged, but came too late for competition.

Landreth & Munns, D. O. Prouty, and Edwin Chandler, dealers in agricultural implements, deposit a number of tools of value to the farmer, amongst which we notice some excellent corn shellers, straw cutters, ploughs, and winnowing machines, all apparently well made, and efficient implements of tillage.

James Young, of the patent agency, No. 50 Commerce street, Philadelphia, exhibits a number of ingenious machines of considerable value in various branches of industry.

To Landreth & Munns, D. O. Prouty, Edwin Chandler, and James Young, we recommend the award of certificates of honorable mention, for the number and general ingenuity of the machines exhibited by them.

. Oliver Evans, of Philadelphia, exhibits a self-adjusting counter spring, which deserves to be brought before the Committee of Science and the Arts; he also exhibits a capital rectangular provision chest and water filter, with an ice apartment, which, after a whole summer's use, appears to be as good as if new.

B. G. Wilder, of Mamaroneck, N. Y., exhibits several of those celebrated salamander book safes, which stood so well an actual test by fire in the city of New York some time ago; they seem to deserve their reputation, and we regret that they came too late for competition.

W. H. Howard exhibits a machine for pressing hats and bonnets, which, in point of ingenuity of design, and excellence of workmanship, is not surpassed by any machine in the exhibition; it seems, in all respects, to be admirably adapted for its purpose, and we must regret that the late hour of its arrival, deprives us of the pleasure of awarding to it a premium, such as it well deserves.

Cottrall's lattice weighted bridge, possesses peculiarities which render it a fit subject for examination by the Committee of Science and the Arts.

Gideon Cox, of Philadelphia, exhibits a variety of specimens of wooden ware for household use, all of which are well made, and appear to be very well adapted to their several purposes. We recommend the award of a certificate of honorable mention to Mr. Cox, for the superior wooden ware exhibited.

Professor Cresson, of the Gas Works, deposits a small iron steamboat, called the "Coquette," which has two small horizontal engines, and has been run at the rate of seven miles per hour; it deserves notice, as adding another to the many successful examples of the

superiority of iron over wood, as a material for the construction of vessels.

Jordan L. Mott's stationary cowl, or ventilator, No. 7, of his advertisement, richly deserves a certificate of honorable mention, if not a medal, as Ewbank's experiments have proved it to be much superior to a cone, showing its apex to the wind, as well as to other forms in common use. Besides, being *stationary*, it neither *screeches* when the wind blows, nor is it at all likely to get out of order, there being no moving, or wearing parts.

In fine we think we can perceive, in the style of the workmanship on some of the machines now exhibited, a sure precursor of future triumphs for American artisans, so soon as the several branches of mechanical industry shall extend themselves further, and occupy more ground in the field of utility.

Report on Stoves, Grates, &c.

The Committee of Judges on Stoves, Grates, &c., have examined the numerous collection of stoves and cooking ranges, and have been gratified to witness the spirited competition which exists among the manufacturers of these important appliances of domestic economy.

This branch of manufactures appears to have attained to one of those stages of maturity at which the further progress of improvement seems to be for a season stayed. Certain general principles, founded on reason and experiment, have been developed and applied to practice, under so many modifications of form, that the ingenuity of inventors is at a stand.

The parlor and hall stoves exhibit under various forms, modified according to the fancy of the maker, but generally involving the principle of diffusing the heat of the fire over an extensive radiating surface; a principle of acknowledged excellence, but one which may be, and is sometimes, carried so far as to impair too much the draught of the fire. The stoves of this class which are thought most worthy of notice, are—

No. 1501, a radiator, by Pleis, Fœring & Thudium.

No. 1620, a radiator, by Jacob F. Pleis.

No. 1707, a radiator, by Weaver & Volkmar.

No. 1720, a radiator, by Williams & Hinds.

No. 1721, an air-tight wood stove, by A. Brenizer.

No. 1714, the crescent stove, invented and deposited by J. W. Kirke, is new and curious in its arrangement; it carries the principle of radiation to its utmost useful limit, and may probably be found to have its draught somewhat impaired by the attempt to obtain the whole heating effect of the fuel.

All of which are considered to be worthy of certificates of honorable mention.

The remarks made above as to the absence of any notable improvement, apply to the cooking stoves and ranges, equally with the ornamental stoves, all of which very much resemble those exhibited for the last two years.

No. 1608, a cook stove, by Durell, and No. 1698, by J. Kisterbock, are both of well known and approved construction, and may be considered deserving of honorable mention. The like distinction is due to No. 1686, a summer stove and baker, by M. Stewart, who has also deposited a double stove on the summer baker principle, which involves the trouble of making two fires in one stove, and is, therefore, not thought to be a judicious arrangement.

The cooking ranges exhibited are four in number, deposited respectively by Lloyd & Feltwell, Julius Fink, F. McIlvaine, and Henry Hallman; the two first named have already received the silver medal of the Institute at previous exhibitions, and, consequently, can now receive no higher mark of commendation than certificates of honorable mention. The other two bear a strong resemblance to each other, and approach so nearly in construction to the former, that they may with propriety be recommended to a like distinction.

In addition to the above, the committee would recommend the award of honorable mention to De Witt C. Mott, of New York, and to C. W. Warnick, of Philadelphia, for the extensive and creditable display of stoves, furnaces, boilers, &c., which they respectively contributed to the exhibition. All which is respectfully submitted by the committee.

Report on Cabinet Ware.

The Committee of Judges on Cabinet Ware, respectfully report as follows:—

It is a source of some surprise to your committee, that, in this city, where the manufacture of cabinet furniture is carried on to a remarkable extent, both in the variety, style, and excellence of workmanship, so limited a display should have been presented to the public eye on this occasion. Notwithstanding, however, the paucity in amount, many of the articles present beautiful models of taste, ingenuity, and excellence of construction; the workmanship, as usual, being of such superior accuracy as to challenge competition, and fully support the well earned reputation of this city, in this department of manufacturing industry.

The committee desire, especially, to call the attention of the Institute, to the centre table, and other articles, Nos. 1319 to 1321, made of American woods, as a branch of the arts deserving of its fostering hand. The workmanship justifies the encomiums bestowed by the public, and is worthy of the beautiful material employed, which cannot be excelled by the productions of this, or any other, continent.

These articles are recommended for the most favorable award within the ability of the Institute to bestow.

The committee would also call attention to the pointed, or Gothic, style of furniture, Nos. 1330 to 1332. Upon such articles as these is based the reputation of our city for superiority of workmanship, and the selection of tasteful forms, in which these articles can scarcely be

surpassed; they are recommended to the most favorable notice which the regulations of the Institution permit.

The committee would respectfully recommend to honorable mention, the articles in the florid style of Louis XVI, Nos. 1222 to 1225; this style has become somewhat the fashion within a few years, and although not based upon classic principles, and of doubtful taste, is highly ornamental. The articles are well made, the upholstery creditable, and of rich materials; the toilet table, particularly, being a very ornamental and tasteful affair.

To John Gibson, of Philadelphia, for the painting of a centre table in imitation of veined marble; of another, imitating various woods, and for a Gothic book-case, painted in imitation of oak, all of which painting is unusually well done, a certificate of honorable mention.

Finally, the committee recommend to honorable mention, the Venitian blinds, No. 1293, which are of much better finish than usual, and work well; in fact, these samples are the best which have come under the notice of the members of the committee, and richly merit the judgment given above.

The committee beg leave to close their report with the remark, that the articles, above enumerated, are all that merit particular notice, (as far as they are able to judge,) of the number exhibited on this occasion. Generally speaking, the Cabinet Ware, though limited in quantity, is equal in quality, if not superior, to that exhibited in former years, and all the articles (with few exceptions) are of such construction and finish, as will authorize us in maintaining the opinion given in the first paragraph of this report.

Report on Musical Instruments.

The Committee on Musical Instruments report, that they have examined the Piano Fortes in the exhibition rooms, with reference to the qualities of their tone, their touch, the regularity of their scales, the prompt action of the dampers, the principles of their construction, the character of the materials employed, and the entire workmanship. One of these, No. 1302, is a grand piano of the largest class; the fourteen others are of the ordinary form, though the action in many of them is that of the grand piano.

The grand piano is from the manufactory of Mr. Thomas Loud, but has been in use for some months as the property of the gentleman for whom it was made. It is, in many respects, remarkable; without, perhaps, any considerable peculiarities that can be called new, it appears to combine the best improvements that have been introduced in Europe, in the structure of such instruments, or that have heretofore been devised by Mr. Loud himself. It has great power and roundness of tone, the bass especially being remarkable for its force and purity; the damping is instantaneous and complete. In the disposition of its parts, as regards beauty, convenience of access, and strength in the materials used, and the neatness and efficiency of the

work, as well as the durability and exterior appearance of the instrument, it reflects high credit on the manufacturer.

Of the other pianos, very few were found below the appropriate standard of a good parlor instrument. The improvement of the art is, indeed, manifest in all of them; and several establishments have shown that they are now in such a state of advancement, as to construct instruments with the certainty that they shall be of the higher grades. After very often repeated trials of all the instruments separately, and again in competition with each other respectively, the committee unite in declaring their preference for the two pianos, marked No. 209, A, from the manufactory of Messrs. Gale & Co., of New York, and No. 1271, from that of Mr. Conrad Meyer, of Philadelphia; and a majority of the committee, as between these two, preferred the former.

The committee, however, abstain from recommending the grant of the Institute's medal, at this time, to either of the competitors. In this they by no means wish to detract from the meritorious character which belongs to their instruments; but they are of opinion, and they act upon the opinion, that this high honor should be reserved for instruments that disclose some distinct and important improvement in the principles of structure, or some singular combination of the points of excellence.

In the same spirit they do not recommend a grant of the medal for the guitar, No. 1346, made by Mr. C. F. Martin, of Nazareth, Penna.; this is an instrument of the Spanish form, graceful in its proportions, and of very fine tone. It was not made for exhibition, having been deposited by a purchaser, but it is so highly meritorious as to invite a special and complimentary mention.

The parlor organ of Mr. Corrie and others, No. 1269, attracted, for itself, much commendation. Its arrangement of the stops and pedals is, in some respects, novel, and allows of every possible variety of combination. The stop denominated the *Euphronia*, contrived somewhat on the principle of the claribelle, may yet be regarded as new. The whole structure of the instrument is handsome, and its tone good.

The serafina, No. 1178, is a very creditable instrument of its class, of rich tone, and suited, by its appearance, to the parlor.

The case of wind instruments, No. 1232, from the establishment of Mr. Weygandt, contains a number of fine flutes, flageolets, &c.; the merits of several of which claim the notice of the committee.

In conclusion, the committee remark, that a comparison of the specimens now before them, with those at the two last exhibitions, gives the most satisfactory proof of progress in the arts of constructing the different Musical Instruments.

Report on China and Glass Ware.

The Judges to whom was assigned the examination of the China and Glass Ware, respectfully report:—

That upon entering on their duties, they found but a meagre dis-

play of those wares, far short of what has usually been submitted to their inspection, and of what might reasonably have been expected. Philadelphia furnishes a market for a large amount of Glass Ware, and the manufacturers of the article would certainly have advanced their own interest had they submitted to the public, through this exhibition, a better variety of what they are capable of producing from their respective factories. It is to be hoped that at the next exhibition they will contribute more liberally.

From P. C. Dummer & Co., Jersey City Glass Company, deposited by E. E. Smith; this company makes the best display of glass ware in the exhibition:

No. 601, one large covered bowl, of cut glass, a beautiful piece of workmanship, but no further notice can be taken of it, because the depositor was not certain that it had not been exhibited before.

No. 601, one cut glass bowl, not so large nor so richly cut as the above, but of graceful form and finish, and decidedly superior in quality of metal. To this piece of ware the judges would award a silver medal.

Nos. 602, 603, and 605, several articles of cut glass, but none of them remarkable.

No. 604, one pair of moulded and cut claret flagons, a very fair article.

From the New England Glass Company, deposited by S. D. Hastings:

No. 613, several pairs of cut salts, rich and beautiful goods; there were some other articles, on the same stand, made by this company, but as they were not on the judges' list, it is presumed they were entered too late for competition. The judges were happy to perceive a decided improvement in the quality of the metal from this factory. To this company the judges would recommend a certificate of honorable mention.

No. 723, one pair of decanters, from the Boston and Sandwich Co., deposited by H. Tyndale. These were sufficient to show that this company maintains its superiority for quality of metal.

No. 652, a lot of glassware from Capewell & Brother, deposited by makers; no improvement on last year's display; there is in this lot a decanter with several apartments for different kinds of liquors, which will receive its meed of praise from the visitors to the exhibition, for its curious and ingenious construction.

No. 722, earthenware from the American Pottery Company, Jersey City, deposited by P. Wright & Son, the quality of the ware is fully equal to that exhibited last year. A cake jar, with a water lute to prevent the admission of ants, or other insects, is a well finished and useful article, deserving a certificate of honorable mention, but the depositor being one of the judges, prevents them from awarding a premium to it.

No. 646, earthenware made and deposited by Abraham Miller; the success that has attended the efforts of Mr. Miller in the manufacture of common earthenware, should prompt him to attempt a competition with the foreign article in the finer kinds. In glass ware a minimum

duty almost excludes the foreign article from our markets, and we trust the day is not far distant, when a like result will be attained in the earthenware manufacture. The display this year manifests an improvement that fully deserves a premium, but Mr. Miller being a member of the Board of Managers of the Institute, the regulations of the Committee on Exhibitions prevent the judges from awarding it.

No. 724, two porcelain baskets, made by Bagaly & Ford, deposited by H. Tyndale, a well finished article for American manufacture.

No. 614, window glass, made and deposited by T. Richardson; there is no competition in this article, which is much to be regretted. It is an important branch of trade, and the manufacture of it should be fostered with especial care. The sample exhibited is a pure material, free from waves, and deserves a certificate of honorable mention.

Report on Hats and Caps.

The Committee to whom the Hats and Caps were referred, beg leave respectfully to report:—

That with the exception of Mr. Donaldson, (who has not at any time been present,) they have carefully attended to the duty of examining the articles submitted to their inspection; but confess themselves utterly at a loss from the superiority of nearly all the articles shown, to form a judgment which might not appear partial; they also take occasion here to say that they have never seen, at any previous exhibition, or time, such quantities of the really well made and beautiful in all the departments of Hatting, and, whether color, quality, style, or workmanship be taken into consideration, your committee are of opinion, that the exhibition of the present year outvies all previous ones.

With one or two exceptions, we are happy to perceive the Hats and Caps are all placed in neat cases; this is an improvement which we think it would be well to insist upon in future exhibitions, on account of security, if for nothing else.

There are two or three invoices, the cases for which were sent to the rooms before 12 o'clock on Tuesday, but from ignorance of the rules, *or some other cause,* the articles themselves were not brought in until after that hour for record. Their quality is such, that we are of opinion, that in these instances a strict regard to rule may be dispensed with, particularly as we know that invoices of some Hats and Caps were entered *before,* and the goods brought in *after* the hour designated. These articles will be noted in their proper places, and the disqualification will then be also noted, that the Committee on Exhibitions may take the order which their judgment on these facts may dictate.

No. 952, a case of hats from James Huns, in Chesnut street, above Sixth; these hats are stated to be taken from the shelves, and are the hats ordinarily kept for sale by the exhibitor; they are of a good color, well made, handsomely finished and trimmed—they are beautiful hats.

No. 976, an invoice of three nutria, and three moleskin hats, from Mr. Orlando Fish, New York, deposited by Mr. Walborn; these hats, in the opinion of your committee, cannot be excelled in their quality, neatness of finish, and general workmanship. They are represented to have been taken from the shelves of Mr. Fish's store, and are his ordinary goods; they are a little heavier than the same kind of hats made in this city. We think they are entitled to honorary mention.

No. 997, several hats made and deposited by Mr. John C. Yeager, No. 163 North Third street; these are beautiful specimens of the art, trade, and mystery of hat making: very creditable to Mr. Yeager, very neat in their appearance, of excellent color, and for the prices placed upon them, cannot be excelled. We are of opinion an honorary mention is due.

No. 1001, one hat of nutria, and one of moleskin, made and deposited by Mr. John Hile, at the North-east corner of Chesnut and Eighth streets; these hats, the committee think, are deserving of commendation, from their lightness, beautiful finish, good color, and excellent style of trimming; their whole appearance is very creditable to Mr. Hile, as a maker of hats.

No. 1002, two children's caps of velvet, made by Mrs. Hile, the wife of the above named gentleman; they are said to be the product of her own hands; they are very neatly made, and the style is alike creditable to her taste and abilities.

No. 1005, a large assortment of hats, caps, and military hats, from Mr. Charles Oakford, Chesnut street; a portion of these goods being locked up, the committee could not subject them to the examination which most of the other articles have undergone; those which they handled are very fine in quality, very neatly, but not quite so elaborately, finished, as most of the other hats in the exhibition; the trimming is in Mr. Oakford's usual neat style. The military hats are (as might be expected) very showy, and exhibit great neatness in their getting up. The velvet caps are very pretty specimens of that kind of goods.

No. 1045, sundry hats, from Mr. Isaac Oakford, South Third street; these hats present the appearance of very well made articles, and are creditable to Mr. Oakford, as a new competitor for public patronage in his business.

No. 1047, an invoice of hats from Oliver Brooks, corner of Third and Walnut streets; these hats are excellent in all respects. Your committee beg leave to note more particularly a patent cassimere hat, exhibited by Mr. Brooks; this is made without seam, the body being made in the usual manner, and the covering made of fine wool, and drawn over the body without stiffening, all that is necessary, is to brush it in the same manner a garment is brushed when soiled. It is a great improvement in this article, that it is free from stiffening.

No. 1054, several hats from the store of Mr. Samuel Mears, in Market street; these hats are well made and got up, and are good specimens of the durable in hatting.

No. 1055, a large octagonal case of hats and caps from Messrs.

Lamberti & Blynn, Market street, near Tenth; Mr. Lamberti has been long and well known in this community as a maker of caps, and his goods have always been characterized by a neatness, and prettiness of style. Those exhibited are beautiful specimens in this respect. The hats are of different qualities, and appear to your committee very commendable for their finish, and, in fact, for all the good qualities of good hats.

No. 1062, from Preston Bishop, a case containing several hats; this case was locked up, and thereby a *feeling* examination could not be made; as far as the eye is of use in determining the nature of the goods, they appeared very well finished, neatly trimmed, and of good color.

No. 1069, one cassimere and one moleskin hat, from Mr. Bird, under the Franklin House; these hats present a very good appearance, well made, good color, &c., &c., in fact, they are what is now looked for in these days of improvement and competition.

No. 1070, one cassimere hat, made by Mr. Nickerson; a well made article, and neatly *got up.*

No. 1072, a case containing four hats, from the establishment of E. Kimber, jr., North Fourth street; these are of excellent color, well made, and neatly trimmed and finished. Your committee think Mr. K. deserving of great credit in the improvement apparent in all these respects.

On the top of this case are two fur bonnets, and one child's fancy hat, which are very pretty specimens of his handiwork in that line; an honorary mention, we think, is his due.

No. 1088, four hats, made and deposited by Mr. Charles Bulkley, whose establishment is under the Philadelphia Banking House; these hats were sent in and recorded a short time after 12 o'clock on Tuesday—the case coming in before. Your committee are of opinion that these hats are deserving of notice; the senior judge declaring he never saw better, and that it is impossible to surpass them in the brilliancy of their color, lightness, and general style of finish. From the relationship existing between the chairman of your committee and the exhibitor, he feels some delicacy in recording the views of the other members, but feels compelled by a sense of duty.

No. 1095, a case of velvet caps, from Mr. Brown, New York, in the same circumstances, in regard to time of deposit, as the hats named above; they are the prettiest article of the kind in the exhibition, in the judgment of your committee, and should be noticed.

No. 1120, two hats, two caps, and one child's fancy hat, from Charles F. Raymond; these are good specimens of Mr. Raymond's manufacture.

James Walker has two hats on stands, which are good specimens of workmanship, and creditable to him as a maker of hats.

Your committee believe they have carried out the views expressed at the commencement of this report, of bestowing pretty general commendation upon the Hats and Caps exhibited. Where there is such a uniformity of goodness, they do not think it just to pro-

pose a medal for any individual: it would seem as if the neatest and best of operatives had outdone themselves, in producing these superior articles. The improvements are owing, in part, to competition in trade, and more particularly to the impetus given by the Institute, which puts forth such inducements to artisans of all kinds to exhibit their handiwork. That the Institute may still progress in the laudable designs of its foundation, is the heartfelt wish of your committee.

Report on Chemicals.

The display of articles in this department is exceedingly beautiful, and reflects great credit on the depositors.

No. 309, a display of admirably prepared chemicals, from Messrs. Wetherell & Brother, among which the oxide of mercury may be designated as particularly good.

The oil of black pepper, and the salarine are also of very superior excellence. The specimens of crystals are also remarkably beautiful.

The exhibition is also indebted to Mr. S. Wetherill, for a highly interesting display of the various Peruvian barks, in their natural state.

No. 335, Smith & Hodgson also deposit a collection of very superior chemical preparations, among which the tannic and gallic acids, and narcotine are remarkable for excellence, and the cyanide of potassium and citrate of iron very good.

No. 327, Frederick Brown also deposits a beautiful case of chemicals prepared by Mr. Trumbull, among which the citrates of iron may be particularly designated.

No. 405, a lot of articles manufactured by Harrison & Brothers. The well earned reputation of these gentlemen is a sufficient voucher for the excellence of these preparations.

The committee were particularly pleased to see the acetate of alumine, the pyroligneous acid, and pyroliquate of iron.

No. 323, a specimen of beautifully crystalized acetate of lead, from the manufactory of Mordecai Lewis & Co., a very excellent specimen from these well known gentlemen.

No. 326, two bottles of cyanide of potassium, an article rapidly introducing itself into practice, as the solvent used in the process of galvanic gilding; a very creditable specimen of chemical preparation from the laboratory of Mr. Worthington.

No. 613, a case of pharmaceutical preparations, designed for the use of students of medicine, arranged and deposited by Edw. Parrish. The articles appear to be of excellent character, are neatly and substantially put up, and seem to be in every way fitted for the purpose for which they designed.

No. 635, a lot of chemical glass ware, made by Stephen Heintz, and deposited by L. Voigt; these articles appear to be excellent, and they unite the suffrage of all those who have used them. The forms of the bottles are well adapted to facilitate pouring, emptying, and cleaning, and every part of the apparatus appears neatly designed

and well executed. The committee did not test the graduations, believing that this will be best done by each purchaser for himself.

Among the articles not properly included among chemicals:

Nos. 306 to 308, loaves and jars of sugar, manufactured and refined without the use of blood, by Messrs. Lovering, of this city; this article is of a very superior character, and the committee consider it as well worthy the attention of the Institute.

No. 346, a box of excellent isinglass, from C. Delacour; this article was exhibited at the last exhibition, but was too late to come under the notice of the judges. It appears to be a very good article, and may be recommended to those who have use for it.

No. 373, some very beautiful glue, deposited by C. W. Gschwind; this has met with high approbation from all who are judges of the article. The committee strongly commend it to attention.

No. 388, adamantine candles, by Hancock & Mann, of Baltimore; this is a very beautiful article, which appears to be taking the place of the spermaceti candle.

No. 351, a lot of articles from Mr. Morfit, exhibiting the products of the various processes in the manufacture of stearine candles from lard; the specimens are highly interesting, and show, in a very clear light, the method of the manufacture. Mr. Morfit claims the discovery of a new method of purification without saponifying, about which claim the committee know nothing, but consider Mr. Morfit, (a very young man) as deserving all credit for his unremitting industry in perfecting and extending this important manufacture.

There are deposits of fancy soaps by Curtis Taylor & Son, No. 301.

Perfumery, by Jules Hauel, No. 324, and N. B. Hinton, No. 347, all of them excellent of their kind; but a great superiority in this article must be accorded to Mr. Roussel, No. 333, for his very beautiful and admirable exhibition of fancy soaps and perfumery. Mr. Roussel's merits have already been decided upon by a great many of our citizens, and the committee can say nothing which would add to his well earned reputation.

The committee recommend the following awards:

To Wetherill & Brothers, No. 309, Smith & Hodgson, No. 335, and Lawrence Trumbull, No. 327, certificates of honorable mention, for the general excellence of their chemical preparations deposited.

To Edward Parrish, No. 613, for the neatness and excellence of his pharmaceutical preparations.

To Stephen Heintz, No. 635, for the excellence of the chemical glass ware deposited by him.

To Lovering & Co., Nos. 306 to 308, for their display of steam refined sugar.

To Charles W. Gschwind, No. 373, for the excellence of his glue.

To Hancock & Mann, No. 388, for the beauty of their candles.

To Campbell Morfit, No. 351, for his interesting display of the various preparations of stearine.

To Eugene Roussel, No. 333, for his admirable display, and the general excellence of the articles manufactured by him.

Additional Report.—Our attention having been called to the article of Jeweler's Rouge exhibited, we have taken the pains to inquire of those who have used it, and find that they unanimously recommend it as a very superior article for jeweler's purposes. We therefore request to have added to our former report, the following recommendation.

For No. —, jeweler's rouge, to Mrs. Mary West, a certificate of honorary mention, for the excellence of the article.

Report on Straw Goods.

The Judges on Straw Goods beg leave to make the following report on the articles referred to them:—

No. 214, specimens of No. 5 and 7, Amazon braid, manufactured by A. Casseli, New York; the braid is purely white, exceedingly even and regular in texture, and of proper quality for the number. This article is deserving of high praise as a domestic fabric, and when made up, presenting a light, durable, and beautiful bonnet, equal, if not superior, in these respects, to any thing of foreign production. The committee would recommend to the manufacturer a certificate of honorable mention.

No. 215, Amazon braid bonnets, made up by S. D. Hall & Co., of New York, who are entitled to praise for the purity they have preserved in the color of the braid, in getting up a neat and tasty bonnet.

No. 1084, a glass case containing Amazon and Florence braid bonnets, manufactured by Thomas White, of Philadelphia; although received too late for competition, yet are entitled to much merit for the superior manner in which they have been made; equal praise is also due to the palm leaf hats, and hair edgings, by the same maker.

Daniel B. Legg has also deposited some hair edging, entitled to attention, but received too late for competition.

No further samples were presented to the committee worthy of mention; we would also further state, that, in our opinion, it is in bad taste to present for exhibition bonnets made up of braid, or other material, of foreign nature, and the more so when that braid gives much more than half the value to the bonnet.

The committee are sorry to add that they are much disappointed in the very poor display of the articles belonging to Straw Goods; the variety and quality is poor, and the quantity very limited. This subject is worthy of more attention by the manufacturers of our country, and we do not err in saying, that over a million of dollars have been paid in one year by the United States, to foreign countries for articles in this line, and even now many hundred thousand dollars are yearly lost to us in the same manner. We have in our land all the variety of raw material, and the specimens in other goods in this hall, certainly prove that our manufacturers have equal skill with those of other lands: we trust that at the next exhibition of this Institution, the Committee on Straw Goods may have no cause of like complaint.

Address of Dr. Robert M. Patterson, *at the close of the Thirteenth Exhibition of American Manufactures, held by the Franklin Institute of Pennsylvania, for the Promotion of the Mechanic Arts, October,* 1843.

Philosophers have long embarrassed themselves in the search after some characteristic difference by which man could be distinguished from the other animals, and which might constitute, as it were, the definition of our species. The power of *speech* has been selected for this purpose; but the babble of the parrot and the jay shows that this power does not belong to us alone. The possession of *reason* has been supposed to be peculiar to man, and to be a sufficient characteristic; but the man who, submitting to the evidence of his senses, will examine the various actions and devices of the inferior animals, many of them of such a kind and under such circumstances as to forbid a reference to blind instinct, and who yet will deny that they are capable of reasoning, must, I think, be himself greatly deficient in this boasted faculty. Another definition of man has been derived from his erect port, and his countenance raised to heaven, so that Aristotle thought he had characterized the species, when he defined man to be *a featherless biped.* But many of the apes, and particularly that caricature mockery of man, the ourang-outang, show that this definition is insufficient; and, you know, that to throw it into ridicule, Diogenes, the laughing philosopher, plucked the feathers from a cock, and, casting it into the school of the Stagyrite, exclaimed—behold the Man of Aristotle!

Franklin, whom we may, I hope without unpardonable irreverence, consider as the patron saint of our institution, has suggested another characteristic of man, and defines him to be *the animal that uses tools.* And, in fact, what is it that has constituted man the head and lord of the animal creation? We know that he is naturally weak; how then has he erected the massive temples, and the cloud-capped towers?—by machinery. He is by nature defenceless; what then has given him such power, that the lion and the tiger tremble before him?—his terrible instruments of destruction. He is naturally naked and exposed; yet by tools and machinery, he forms, from the wool and fur of animals, and the fibres of plants, clothing, so well suited to the circumstances in which he may be placed, that he inhabits, with comfort, every climate. His sight is limited; but, by the aid of instruments of his manufacture, his view is extended from the minutest atom, to the distant worlds which circle in the heavens. While other animals have the enviable faculty of traversing the air and the waters, he is naturally confined to grovel on the surface of the ground; but he has constructed the silken balloon, in which he may soar in safety above the clouds, and the majestic ship, in which the ocean is made his highway, and the winds his ministers.

Without pretending to consider this subject further, in the point of view in which I have presented it, it is impossible not to perceive, that it is to tools, implements, and machines, of various kinds, extra-

neous to man, and not furnished to him by nature, that he is principally indebted, not only for his control over the rest of the animal creation, but for his own immediate protection, comfort, and subsistence. It is evident, therefore, that to foster and promote the mechanic arts, must be ever one of the most rational and effective means of advancing the interests of society.

Under this impression, and with this purpose, the Franklin Institute of Pennsylvania was founded, twenty years ago; and how much has it not already accomplished! Its professed objects are, as you know, to advance the useful arts, and to improve the condition, character, and prospects of the industrious class of citizens by whom they are exercised; and the means by which it proposes to accomplish these objects, is the general extension of useful, practical knowledge. The workman who understands nothing of the principles of his trade is rather to be termed a *machine* than a mechanic, and will certainly never make any improvement in his business.

Of the means of acquiring a knowledge of any mechanic art, there is one which cannot be brought within the province of the Institute, but which yet occupies a high rank; it is the instruction which is obtained in the workshop, under the direction of a master. It becomes us to be upon our guard against the ridiculous boast of those who call themselves self-taught. It is a fallacy and a deception. Examine the matter closely, and you will find that self-taught means half-taught. He that undertakes to teach himself a trade, is sure to have an ignorant master.

But if a trade be confined to what is learned during apprenticeship, it can never be improved. The ambitious mechanic and manufacturer will not be content to follow in the exact footsteps of his master: for it is a pregnant truism, that he who always follows must always be behind. The intelligent artisan, will, therefore, not fail to extend his inquiries as widely as possible; he will seek to learn what improvements have been made in tools, machinery, processes, and materials, at home and abroad, and he will make a study of those sciences which have a bearing upon his trade, while he will be cautious how he rejects any accessible knowledge because he may not see its immediate connexion with his business.

Of the means employed for the communication of knowledge, *books* are certainly among the most important. It is with as much justice as force, that printing has been called the mother of the arts.

The formation of a library was one of the first objects proposed by the Institute, and it has persevered in it constantly and successfully, so that now its collection of books is large and valuable, and opens to the members sources of information on almost every subject likely to excite their interest. Besides the larger works in the library, European and American periodical publications are taken, on the various subjects cultivated by the visiters to the reading room, and the journals of the day are also laid on the table, so that the reader cannot fail to spend his evening in a manner which shall be at the same time amusing and instructive, and, let me add, innocent.

A journal devoted to the objects of the Institute has been conducted under its patronage almost from the time of its foundation. I have no hesitation in saying that it has been, and is, a most useful work, worthy of all encouragement. To suppose that such a publication can be conducted in a way which shall suit the particular tastes and objects of every reader would be absurd. The founder may take no interest in the polishing and varnishing of woods, and the cabinet maker, might, perhaps, willingly dispense with a long essay upon alloys. It is the business of the editors, however, to cover, as far as possible, the whole ground of the useful arts, and to give to every man a just share of the matter which most concerns and interests him. In this respect, I think that the journal has been conducted with skill and discretion; and, knowing it to be calculated for extensive usefulness, we hope that it may not fail to command your continued and increasing support.

But it must not be supposed that books, although they are certainly among the most essential vehicles of information, are always sufficient for the purpose. There are many departments of knowledge which books alone are not able to communicate. These require the exhibition of experiments, of models, of drawings; and they require to be illustrated and enforced by oral instruction. The Institute has accordingly procured sets of philosophical and chemical apparatus, a valuable collection of models, and an extensive cabinet of minerals. It also, in its earliest days, established the necessary professorships; and courses of lectures, on various important subjects, are delivered annually. A series of these courses is now about to be commenced at the Hall. They will comprise the subjects of Mechanics and Physics, by Professor Cresson; of Elementary Chemistry, and of Geology, by Professor Frazer; and of Chemistry applied to the Arts, by Professor Booth.

Natural Philosophy and Chemistry may be considered as forming the essential ground work of the useful arts. The mechanician who is ambitious of laying claim to a skill in his business which is more than the result of mere habit and imitation, must not neglect the study of those sciences. So important, indeed, have they been considered, that it was principally for the sake of making them accessible to practical workmen, that this Institute was originally established. Of the gentlemen who now hold these professorships, I will let public fame speak, for I know how distinct is her voice in their favor. As to myself, I am free to acknowledge that the warm predilections of personal friendship make me an unfit witness.

Another most useful department of instruction is presented in the Drawing School. To what embarrassments are not our workmen and mechanicians often exposed, from their ignorance of this most important art? With what awkwardness and difficulty do they express their ideas of machines, buildings, furniture, and a thousand other objects, merely because they cannot draw. Indeed there is scarcely a trade in which the possession of this art might not prove beneficial, and its more general cultivation is therefore greatly to be desired.

The professor in this department is Mr. William Mason, who, to the skill of an artist, adds the experience of a teacher.

In enumerating the means of communicating information presented by the Franklin Institute, it would be an unpardonable neglect, on my part, were I to omit the labors of a branch of the Institution, comprising a large body of its best informed and most active members, and organized under the title of the Committee of Science and Arts. It is, in truth, the Scientific Board of the Institute, and, as such, its transactions have been of the most important character. I offer, as examples, the admirable investigations on water-wheels, and on the explosion of steam-boilers, of which the reports are given at large in our journal. As to the latter, it seems to have nearly exhausted the subject; at least I have not seen that the expensive experiments since made by the order, and at the cost, of the Government, have added any thing of importance to our knowledge in this matter. But these were special labors of the Committee. Its ordinary business is of a different character. It is its duty to investigate the merits of every invention, claiming to be original, and offered to its consideration, and to make written reports of the conclusions to which it has been led. A long connexion with this Committee has enabled me to witness the importance of these investigations and reports. In numerous instances, they have served to bring into public notice neglected results of inventive talent, and thus to encourage and reward true merit. In many others, the projector's expectations have proved to be ill-founded, and he has been advised to abandon his schemes, and has been thus saved from useless expenditures. But of all the results, the most usual is, that ingenious contrivances, truly inventions of the applicants, and believed by them to be new, prove not to be original, but to have been invented by others before them. Such information is of great importance to the supposed inventors, by preventing them from taking out patents which cannot be sustained, and thus saving them from loss and litigation.

The last of the means of information and improvement, employed by the Franklin Institute, to which I shall call your attention at this time, is the establishment of public exhibitions, to which the mechanics and manufacturers of the United States are invited to send the productions of their several branches of business. The first of these was held twenty years ago. I remember it well. It was given in the lower story of the Carpenters' Hall; and limited as was the space, it still presented "room and verge enough" for all the articles that could be collected. We were proud of this exhibition; we thought it eminently successful; we boasted of the advancement which it showed in our domestic arts and manufactures. What a land is this that we live in! Improvement makes its progress among us with locomotive speed; and twenty years ago is an antiquity when viewed in connexion with our country's advancement. Let those among you, who, like myself, are old enough to deal in reminiscences, compare the meagre display of our first exhibition with the noble richness of our last; of that which now fills the vast saloons of this great building, and which you have all been viewing, I am sure, with

pleasure and with pride. How wonderful is the contrast! Yet it is but an index of the improved condition of our country. This colossal structure does not more exceed the old Carpenters' Hall—this latest exhibition does not more exceed the earliest—than do the products of our skill and industry exceed those of a period but four short lustres since.

It is no part of my task to give an account of the present exhibition. This has been already done in an interesting report from the appropriate Committee, which was read by their chairman, Mr. Weigand, on Tuesday last. On this occasion the opinions of the judges were announced, and medals and certificates awarded, which, as care is taken that they be given to the most deserving, may well gratify the ambition of the successful competitors.

And now, ladies and gentlemen, I have laid before you, as briefly as possible, an account of the measures adopted by the Franklin Institute, for carrying into effect the objects for which it was founded; and I have directed your attention, in the last instance, to the evidence of progress in the useful arts, presented by this, our Thirteenth Exhibition of American Manufactures.

If we take a wider view of this last subject, we shall see that the great improvement witnessed here is but an example and a part of a general increase in the means of extending the comforts and luxuries of life which has taken place over the whole civilized world. It is true that these benefits are very unequally distributed; yet can it not be doubted that the average condition of mankind is raised and improved by the increased facilities of production and manufacture. Who is there at the present day, that cannot be comfortably fed, lodged, and clothed, if, indeed, he be not degraded and impoverished by vice? And as to the luxuries of life, how wide now is the circle over which they extend. The imperial Elizabeth of England had to be content with rushes strewed over the floors of her palace; scarcely have we now a mechanic so poor as not to indulge himself in the luxury of a carpet. This desirable improvement in the physical condition of man has gradually increased, and is still increasing; and with the vast resources which nature has placed at our disposal, it is hard to conceive the limits by which it is to be bounded.

What then is the magic influence by which this important purpose has been, and is to be, effected? It is not by labor alone, nor is it by science alone; but it is by their union. "Practical mechanics," says Sir John Herschel, "is, in the most pre-eminent sense, a *scientific art;* and it may be truly asserted, that almost all the great combinations of modern mechanism, and many of its refinements and nicer improvements, are creations of pure intellect, grounding its exertion upon a moderate number of very elementary propositions in theoretical mechanics and geometry. It would require not volumes merely, but libraries, to enumerate and describe the prodigies of ingenuity that have been lavished on every thing connected with machinery and engineering. By these it is that we are enabled to diffuse over the whole earth, the productions of any part of it; to fill every corner of it with miracles of art and labor, in exchange for its peculiar com-

modities; and to concentrate around us, in our dwellings, apparel and utensils, the skill and workmanship, not of a few expert individuals, but of all, who, in the present and past generations, have contributed their improvements to the processes of our manufactures. The transformations of chemistry, also, by which we are enabled to convert the most apparently useless materials into important objects of the arts, are opening up to us every day sources of wealth and convenience of which former ages had no idea, and which have been pure gifts of science to man. Every department of art has felt their influence, and new instances are continually starting forth of the unlimited resources which this wonderful science developes in the most sterile parts of nature."

It should ever be an aim, then, of those who would improve their race, to bring science to the aid of manual labor; and such, in fact, is the great purpose and business of our institution. This, then, is a fitting time and place, for coming out in the defence of intellectual labor. But is this necessary? Yes! It is not to be denied that a prejudice (though happily it be a diminishing one) exists against what is contemptuously called headwork. It is looked upon by many as no better than idleness, and men who do not work at a trade are too often viewed with jealousy, as mere consumers of the produce of others' labor. So far has this been carried, on some occasions, that attempts have been made to put down these idlers, and to resist their acknowledged influence in society; and, for this end, political parties have been formed of persons calling themselves the *working men*. *The* working men, forsooth! And who, in this community, except a few dandies and loafers, are not working men? Is it the lawyer, who, after years of preparation, is now spending his days in the court room, and his nights in the office, in anxious, responsible, and fatiguing business? Is it the physician, who, in the exercise of his arduous and painful profession, wastes his own health that he may restore yours, and endangers his own life that you may live? Is it the minister of religion? Is it the engineer? Is it the teacher? Is it the merchant? No one could be so preposterous as to suppose it. Where then are we to find this envied class of individuals—this race of nobles—who, while in idleness themselves, are living on the labor of others? If you would find them at all, you must look for them—in the Alms House!

Let me assure my hard handed friends, that their envy of professional men is unfounded. These men should rather be objects of their pity; for of all the varieties of labor to which we can be exposed, the labor of the mind is the hardest. I will appeal to almost any mechanic to say, whether, of the many duties of his business, that of making up his accounts, and posting his books, is not the most irksome,—that which, of all others, he is most apt to postpone, even to his own injury. Yet is such a task mere play, in comparison with the true intellectual labor of the mental workman. What college student would fail in his task, of Greek, or mathematics, if it could be performed by any bodily exertion. Depend upon it, if learning could be attained by sawing wood, or breaking stone, the world would be filled with

scholars. If now there be but few, it is because few can withstand the pain, the fatigue, the wearing down of the constitution which accompany continued mental labor. Why, even the weaving of words and sentences into such a fabric as may not be altogether unfit to be presented among the articles of this exhibition, is harder work, and requires for its execution a longer apprenticeship, than any labor of the hand-loom.

Those profound thinkers who direct their labors immediately to practical purposes, and who do so with success, are sometimes happy enough to secure, at once, the respect and gratitude of their fellow men. Arkwright, the inventor of the spinning-jenny, gave rise to a revolution in manufactures, which has had more influence upon the destinies of the earth, than all the wars of Napoleon. Watt, by bringing to perfection the steam engine, created, and subjected to the service of man, a race of Titans, the obedient and legitimate slaves of his will. Such services are obvious, and are appreciated. But the pursuits of science are by no means always of this character. The philosopher is generally led forward in his investigations, not by any immediate views of practical utility, but by that strong impulse of *curiosity*, which God has been pleased to implant in a few superior minds, appointed by himself to give light and knowledge to the world.

Now sordid and ignorant men are in the habit of ridiculing these men, and their occupations. When they see the mathematician poring over his symbols, to them more unintelligible than the hieroglyphics of Egypt,—when they see the mineralogist collecting stones, and the botanist peering at flowers and weeds by the way side,—when they see a Franklin flying kites, and a Newton blowing soap bubbles, they sneer at the trifling occupations, and superciliously demand—*cui bono?*—what is the *use* of all this?

Now, the terms *good* and *useful* are very difficult to define, and will be differently applied by different persons. For my own part, I would give a high place among the advantages of knowledge, to the *pleasure* which it is capable of affording us. Pleasure—innocent pleasure—is itself a *good*, and he who presents us with a new source of pleasure, confers a benefit which may be truly called *useful.* Even the rigid utilitarian acknowledges this, provided the pleasure be to his own taste, though he may scorn the mere intellectual enjoyments of the philosopher. An example will show this:

Some years ago, Sir David Brewster invented an optical instrument, familiar to you all, called the *kaleidoscope.* In this contrivance, by means of repeated reflections from two plane mirrors, an object, without regularity or beauty in itself,—made up of broken beads, crooked pins, and the like,—had its image multiplied in the sectors of an entire circle, so as to present a form beautiful from its perfect symmetry. This instrument, capable of presenting such pleasing images, and of varying them to infinity, was in every one's hands, and excited universal delight; and Brewster might boast of having solved the problem of the Roman Emperor, and invented a new pleasure. Yet our satisfaction was continually interrupted by the remark:—well, this is

very pretty, to be sure, but what is its *use?* At last some Birmingham and Manchester men bethought them of using the instrument to suggest figures for carpets and paper hangings, and our houses were ornamented with kaleidoscope patterns. At once the utilitarian was satisfied, and acknowledged that the kaleidoscope had made itself useful. He did not reflect, that, while the figure on the floor, or the wall, was not half so beautiful as its optical prototype, it was also not a whit more useful: but then he had a taste for domestic ornaments, and none for philosophical experiments.

Investigations having their origin in pure curiosity, and which often reward their projectors only by the pleasure which arises from the discovery of new facts, are, when fully prosecuted, seldom, if ever, barren, in direct applications of practical importance. Such consequences, often very remote, are not, indeed, the inducements which lead the lover of science in his labors. For him, the instinct of curiosity is sufficient. But as practical utility is a test required by the mass of men, I agree, for the moment, to submit the pursuits of the philosopher to this trial; and in the selection of examples, I am embarrassed only by the multitude which press themselves upon my notice.

My first is taken from an old experiment in chemistry. Never, perhaps, was there a man possessed of a more insatiable curiosity than Roger Bacon. He was constantly applying to nature to teach him her secret mysteries, and he interrogated her in the only language to which she will answer—the language of experiment. In his day, the false science of alchemy was in vogue, and thousands of combinations were tried, in order to discover, if possible, some method of forming the precious metals. The research was vain as to its intended object, but not always so as to other practical results. Numerous important facts were observed, which laid the foundation of the true science of chemistry. Among these, Bacon discovered that if charcoal, sulphur, and saltpetre be combined, they form a mixture which explodes by fire: this mixture is *gunpowder*. The experiment was undoubtedly a curious one; but could any man, at that time, have anticipated its tremendous consequences? Yes: there seems to have been one, and it was Bacon himself. His prophetic mind suggested to him the terrible applications that could be made of his discovery, and he did not dare to take the responsibility of putting such an instrument of mischief into the hands of his fellow men. He concealed his discovery in an enigma, which he terminated by the tantalizing words—"et fias tonitru, si scias artificium;"—that is, to give a free translation,—"and you may produce thunder, if you can find out my secret." The secret *was* found out, and the discovery, to which the curiosity of Friar Bacon had led him, produced a revolution in the world. A new power was created which would tear solid rocks asunder. The fleetest animal could not escape the swift messenger of death propelled by gunpowder, and the most savage dared not to contend with it. Weapons wielded by personal strength became insignificant in comparison with the superior force of fire arms; and the whole system of

war, by which the destinies of mankind have been so much governed, was changed.

Many years before the commencement of the Christian Era, some curious observer discovered, that when amber was rubbed, it acquired the property of attracting light bodies to it, and holding them suspended. For ages this remained an insulated and unprolific fact, and the experiment was considered a trifling one by all but those who had learned that no truth is unimportant. At length the experiment was resumed. It was found that many other substances possessed the same property as amber. The apparatus was enlarged, and new phenomena were presented,—light, and heat, and sound being produced. Means were then found for collecting, and, as it were, bottling up the mysterious agent of these phenomena, and effects of the most astonishing kind were presented. In a word, discovery after discovery was made, until the new science of *Electricity* was offered to the wonder of mankind. The electricity accumulated in large machines, and particularly in the Leyden battery, exhibited appearances and produced effects which seemed to simulate the lightning, though in a feeble degree, and the identity of the two was suspected. Our own Franklin, who had acted a conspicuous part in the science, had a curiosity not to be satisfied by mere speculation, and he determined to test the suspected identity by direct experiment. For this purpose he adopted an expedient characteristic of his mind, which seemed always in a playful mood, even when laying the foundations of a science, or of an empire. He made a common boy's kite; surmounted it by a metallic point, of which he had himself discovered the remarkable electrical properties; depended upon the hempen cord, with a key fastened to the end of it, for his conductor; and insulated the whole by a twine of silk to be held in the hand. Aware of the ridicule which so falsely attaches itself to such pursuits, he went secretly to a common on the skirts of this city, and raised his kite. A promising cloud passed over, and electricity was eagerly sought for in the apparatus, but none appeared; and disappointment and chagrin threatened our philosopher, when a shower fell, and the wetted cord became a better conductor. The knuckle was again applied to the key; several distinct sparks of electricity were given off, and the great discovery was completed. It was proved that the lightning which charged the clouds, was the same substance as that, which, in the amber and glass, had raised the wonder of the philosopher, and the sneers of the utilitarian. The thrill of pleasure which this experiment excited in the breast of Franklin, was not confined to him alone. The discovery was hailed with enthusiasm over the whole civilized world. And what produced this universal feeling of pleasure? It was the gratification of an intense curiosity. No one could be so dull as not to desire to know the cause of the terrific phenomenon of the thunder storm, and the Philadelphia experiment told to the world this great secret of nature. Was not this enough? Must some matter of fact man chill the general enthusiasm by his cold inquiry—*cui bono—what's the use?* Yes: the inquiry *was* made, and most triumphantly was it answered; for the discovery met immediately with its practical

application, in the invention of the lightning-rod, that noble contrivance which gives us security amidst the most frightful turmoil of the elements, which robs the lowering thunder cloud of its terrors, and lays the red bolt of Jupiter harmless at our feet. The discovery of Bacon brought weapons from the infernal regions, to carry death among the ranks of men: the discovery of Franklin disarmed heaven of its artillery, for their preservation.

If philosophers, in the investigations which they undertake, cannot foresee the practical conclusions to which they are to lead, they have yet too many proofs, such as the above, of the utility of all natural science, to permit them to doubt that their pursuits are to bring about good, as well as gratification. It is the dull and ignorant only, who, utterly incapable of receiving pleasure from the discovery of truth, also doubt, or affect to doubt, its importance. How signally is their scepticism often refuted by the most unexpected results! Of this, let me ask your attention to one other example.

The gases, which are transparent and colorless, present no exterior appearances by which they can be distinguished, and they were accordingly all confounded with atmospheric air. Little was it suspected that they really differed as much from one another in their properties as do the metals, or any other bodies; but at last the investigations of pneumatic chemistry proved this to be the case. Among the experimenters in this department, the earliest after Black, and the most successful of all in the discovery of facts, was the celebrated Priestly. His curiosity on the subject was insatiable, and led him to the most singular researches for its gratification. Among these was the examination of the noisome air which rises from stagnant pools. Methinks I see the supercilious dandy turning away his offended nose and resorting to his pouncet-box, and the coarse groom bursting with unrestrained laughter, as they see the old philosopher raking the mud of a horse-pond, and carefully collecting the gas which bubbles up from the bottom. How absurb an occupation, in the eyes of ignorance! Now mark the discoveries of which this was the first step. The gas is taken to the laboratory. It is found to be inflammable, and to be much lighter than atmospheric air. Analysis proves that it is a compound of hydrogen and coal, and it is named carburetted hydrogen. It is obtained from other sources, and particularly from the distillation of bituminous coal, which yields it in great abundance, and also in greater purity. Thus far curiosity has led the research, and its gratification has been the only reward; but now begin the practical applications.

The gas is found to burn with a bright flame. The happy idea is suggested of using it for lamps instead of oil. The experiment is tried upon a small scale, and is perfectly successful. The scale is boldly extended. Immense laboratories are built; huge gasometers are erected; iron pipes are laid for miles in extent; and to every part of the largest cities there is conveyed a source of light which rivals that of day. The effect is wonderful—is magical; and the utilitarian is forced to acknowledge that it is also most beneficial.

But another application of this gas has been made to a purpose no

less astonishing. Of all the attributes in which other animals excel man, (and they are not a few,) there is perhaps none so much a subject of desire, I may almost say of envy, as the power which the birds possess of flying through the air, while we are confined to the surface of the earth. Accordingly, means of traversing the air have been eagerly sought after in all ages, and the history of inventions furnishes us with numerous records of vain attempts to attain this object. The problem was at last solved, in part at least, by the air-balloon, which consists, as you know, of a large reservoir of silk filled with a gas lighter than the atmospheric air. Now, the gas which we have been considering, possesses this property, and from the ease and economy with which it can be made in large quantities, is the best calculated for this purpose. By its aid man can be transported through the air on silken wings, soar to a height from which he might look down upon the Andes, and return to the earth in perfect safety. He can more than realize the fable of Icarus, and without its fatal termination.

The system of gas-lights, and the air-balloon, are two of the proudest triumphs of science and art. Let me call upon you to look back, from the exhibition which I have made of them, to the picture which I first presented, of a little man in black, curiously engaged in the apparently childish occupation of gathering air bubbles from a stagnant pool. The occupation of Priestly was *not* childish. He was in search of a jewel more precious than the diamond. He was in search of *truth*. He found it; and it now occupies a brilliant place in the diadem of jewel truths which crown the memory of a philosopher, to whom Pennsylvania has the honor of having afforded first an asylum from persecution, and then a grave.

I have now laid before you the views which led to the establishment of the Franklin Institute,—have pointed out the means which it employs for carrying these into execution,—and, in doing so, have found it necessary to defend the labor of the mind from the accusations of ease and inutility. We have seen that the great principle which serves, with most assurance, to advance the useful arts, and to improve the condition of man, consists in combining the work of the intellect with the work of the hand; so that what the researches of science have produced as abstract truths, the hands of labor may turn into results of practical advantage. Labor and science, if in singleness, may be regarded,—the former as a sturdy bachelor, rejoicing in his thews and sinews,—the latter as a maiden, conspicuous for her beauty and attractions,—but both barren. Joined in the bonds of a holy union, they are prolific of good, and their offspring are individual comfort, plenty, and refinement, and national strength, independence, and prosperity.

And now, ladies and gentlemen, it only remains for us to thank you, as the honored representatives of the Philadelphia public, for the favor by which we have been sustained amidst our arduous though voluntary labors, for the patronage with which our exhibition has been honored and rewarded,—and for the kind attention which we have received from you, in this our closing scene.

Mechanics, Physics, and Chemistry.

In the "Journal für Praktische Chemie," for May, 1843, an essay appeared by Carl Hochstetter, embracing a series of experiments on Sugar, subjected to various actions, and chiefly designed to develope the action of the substances contained in the juice of the Sugar-beet, as well as those with which the Sugar is brought in contact in the course of manufacture. The first part of the essay referring only to the Sugar-beet, we shall confine ourselves to the subsequent portion, which will apply to the manufacture of Sugar generally. J.C.B.

Behavior of pure solutions of Sugar under different actions and circumstances; by Carl Hochstetter. *Translated by* Oehlschlager, *and communicated to the Journal of the Franklin Institute by Wm. M. Davis.*

Both in the tropical and home manufacture of sugar, the sugar obtained by expression, or maceration, is only partially preserved in its original state, that is, as cane-sugar. Even before it had been proved to a certainty, that the sugar-cane, and the beet, contained only cane sugar, it was admitted that a large portion of the molasses of the sugar refiner, is to be attributed to a change of the cane-sugar under different influences during the process of preparation.

The early fermentation of saccharine vegetable fluids, which have been expressed a phenomenon very common in the manufacture of sugar in the tropics, proves the action of the nitrogenous substances contained in these juices, for, as far as our present experience goes, they alone can produce those changes which we denominate fermentation.

The observation that after the continued boiling of a solution of sugar, only a part can be preserved as sugar fit for crystalization, points out heat as another agent, or influence.

There is no doubt that the influence of such agents diminishes the yield of the refiner; but I doubt whether a correct judgment has been formed of them, and without this, improvements in the manufacture of sugar are not possible.

To obtain this end experiments had to be made on a small scale. These I made by trying to submit solutions of sugar to the influence of the same agents to which the sugar in the juice, and during the whole process of preparation can be submitted.

In consequence of the insufficiency of chemical expedients to separate the newly formed kinds of sugar from the cane-sugar, and to determine their quantity, I found it impossible to ascertain the exact degree of decomposition which I observed under different influences. It is true that more recently the polarization of light has been applied to determine the quantity of the different kinds of sugar in a solution, and the degree of transformation of the sugar under different influences; I, however, did not apply this method, as it could only be of use to me in a few observations, but would be entirely inapplicable for the greater part. I moreover doubted the correctness of the re-

sults in these cases, for reasons to which I shall revert hereafter. The results of this method, as given in the works of Ventzke,* and Soubeiran,† I have, however, constantly compared with my own.

I.—*Influence of atmospheric air upon a pure solution of Sugar, at a common temperature.*

Sugar dissolved in pure distilled water can be preserved for weeks in closed vessels, without undergoing any changes; but if, on the contrary, we expose a solution of about 10° B., to the air in a tumbler, and protect it against dust, we find already after three days, traces of altered sugar, which increase daily. This fact had been observed before, and the change in the second case had been attributed to the organic substances contained in the air.

But whatever probabilities may favor this opinion, it would almost appear that the atmospheric air had an immediate share in bringing about these changes, for pure solutions of sugar, a large part of which is exposed to the air, change in a very short time. The following experiment will show this to be correct:

I filled a glass cylinder, open at the top and at the bottom, with broken glass, like an acidulating vessel for the quick vinegar process, and gradually dropped a pure solution of sugar, the purity of which I had before ascertained by the copper test, slowly, and in such manner, into it, that the air found unimpeded access. The liquid running out below, I continued to pour in at the top. The temperature of the surrounding air was 15° R. After six hours labor I found already altered sugar, for, on mixing with it sulphate of copper and alkali oxidule, (protoxide of copper) was separated. This change increased rapidly, and after 36 hours of operation, the decomposition had progressed so far, that, on evaporation under the air-pump, first, no crystalization was obtained, and after many trials, only a very sparing one. The liquid had remained colorless during these trials, but had become somewhat dimmed.

Whether the effect is produced by the influence of the oxygen of the atmospheric air, or by the organic substances, this experiment proves that considerable contact with the atmospheric air, can change a pure solution of sugar.

Influence of heat upon the pure solutions of Sugar in boiling.

A solution of sugar boiled for some time, or exposed to a temperature above boiling water heat, decomposes itself, as has been observed by many, and loses its power of crystalization. At the same time several new substances are formed, such as uncrystalized sugar, by some called sirop sugar, and noticed as a peculiar kind of sugar, formic and acetic acid, ulmic and ulmic acid.

These changes and transformations, under the influence of water and of heat, progress very slowly. To obtain a distinct view of the changes of a solution of sugar in boiling, a continued action of several hours is requisite. Many experiments made on a large scale, almost

* See Journal für Pr. Chemie, vol. xxv, p. 65, and vol. xxviii, p. 101.

† See Journal für Pr. Chemie, vol. xxvii, p. 281.

made me doubt the pretty generally received opinion, that the greatest part of the molasses obtained in the preparation of sugar, is sugar destroyed by heat. The previous experiments, where sugar solutions had been boiled for twenty-four hours and more, could not be considered as a practical standard; I therefore made the following experiments several times:

A solution of pure sugar of 25° B., I boiled in an open bowl at one trial for 1 hour, at another for 1½ hour, and at a third for 2 hours, and in such a manner that the evaporated water was not replaced until the temperature of the boiling mass had reached 110°—112°C. Even after two hours boiling in this manner, the mass remained colorless; left under the air-pump for crystalization it proved very copious. The liquid, after having been separated from the crystals for some time, formed a solid mass; but decomposition had taken place notwithstanding, for the test by copper showed traces of uncrystalized sugar, and when heated with lime-water the liquid changed to a yellow color. This experiment, repeated frequently, always produced the same result. When the solution of sugar is boiled in an alembic, the sugar undergoes a greater change than in the bowl; the time that the sugar is under the influence of heat being the same. It is difficult to account for this, for we might more readily suppose, that, as the air finds freer access to the bowl than to the alembic, the contrary would be the case. Perhaps this difference of behaviour, when boiling in the alembic, is caused by the flowing back of the water of condensation, which itself aids in the decomposition of the sugar through fermic acid, which cannot be known by any test.

This may be the cause that Soubeiran, in his experiments, after the effect of a boiling heat of two or three hours, discovered considerable decomposition. In boiling sugar for a longer time, it becomes evident that the decomposition, under a more protracted influence, proceeds more rapidly than in the beginning of the experiment, because the products formed by the first action, aid in the decomposition of the sugar, and the more of these there are formed, the more will the transformation be accelerated.

According to Soubeiran, a solution of sugar decomposed by boiling, reacts strongly acid, and, in this case, the acceleration of the process of decomposition can easily be explained. I have not been able to ascertain whether a solution of sugar, which had been boiled for a long time in an open bowl, reacted as an acid upon litmus paper, yet there are in this liquid, acid products, which, as soon as alkalies are introduced, immediately destroy the alkaline reaction. Mixed with calcareous earths, we obtain partly indissoluble compounds. The formation of volatile and *non-volatile* acid products is incontrovertible, and from this we may deduce, that fruit and grape sugar must be formed in the same manner as when acids act upon cane sugar. The opinion that a peculiar kind of sugar is produced by the decomposition of cane sugar, appears to me, therefore, very hazardous. Ventzke* calls this sugar sirop sugar, and mentions, as its peculiar

* See Journ. für pr. Chemie., vol. xxv, 2nd series, p. 75.

quality, that it does not polarize the light. If we compare the phenomena, which accompany the transformation of sugar during ebulition, with the effects of diluted acids, we shall find considerable analogy, for in both acid products are the result. We may also take it for granted, that as soon as acid products have been formed, they exert their influence in such a manner as to generate fruit and grape sugar, and other productions. The perfect neutrality of the mass of sugar, examined by Ventzke, may, therefore, be accounted for on the principle, that grape sugar and fruit sugar existed in such proportions as mutually to destroy their power of polarization. A separation, or isolation, of these two kinds of sugar has hitherto been found impossible, by crystalization it would scarcely be possible to separate them.

To observe the influence of atmospheric air upon a boiling solution of sugar, a solution of 15° R., was boiled in an alembic, and a continued stream of atmospheric air guided through the boiling liquor, by means of a forcing pump (aspirans.) The influence of the air could not be mistaken here, for in less than one hour and a half the saccharine fluid had become considerably darker. The test by copper indicated a considerable decomposition, and the crystalization of the sugar, under the air-pump, was more difficult, leaving behind a darker colored sirop, than in those experiments where the boiling solution of sugar had not been similarly exposed to the air, for, in boiling in the open air, the generated steam prevents the contact with the air.

These experiments prove that the action of the heat in boiling solutions of sugar on a large scale, under the same circumstances, and during the period of ebulition, produces no observable effect when the solution is pure; but that the action of the oxygen of the air aids materially in effecting a transformation in the cane sugar.

Behaviour of the solutions of Sugar under the influence of Alkalies.

That cane sugar combines with alkalies, that from this combination it can be separated again by acids, without any alteration in its form, is known.

In the manufacture of sugar the combination with lime is of great importance; although it has often been demonstrated that lime stands in the same relation to sugar as all the other alkalies, yet the general opinion that large quantities of lime added to the saccharine vegetable juice destroys the sugar, is still prevalent among a large number of sugar refiners. To ascertain this point, and, at the same time, to obtain a knowledge of the behaviour of alkaline solutions of sugar under the influence of different agents, the following experiments were made:—

I prepared sugar lime, by digesting a solution of sugar with caustic lime, at a common temperature, and, after filtering it, I obtained a liquid saturated with lime, and as clear as water; of this I made use in all the subsequent experiments.

When this solution of sugar lime was mixed with carbonic acid, heated to a boiling heat, to drive off the excess of carbonic acid, and the liquid was separated, by filtration, from the carbonate of lime,

which had been formed, I obtained, after evaporation under the air-pump, a sugar perfectly pure, which, when dissolved, and the test of copper applied, did not show a sign of decomposition. Another part of this solution of sugar lime I boiled for two hours constantly over a free fire, always supplying the evaporated water; after which time I used carbonic acid in the decomposition, and the sugar made its appearance as in the foregoing experiments. One part of the solution of sugar lime I reduced by evaporation in a china bowl over the lamp, keeping it constantly boiling; the temperature rose to 120° C., (248 Fahr.) As the mass at this point became so thick, that I could not stir it, it was partially burnt, and the smell indicated the products which sugar forms when distilled dry with alkalies; after cooling, the whole mass was hard, so that it could be reduced to a powder. I separated the white pieces from those which had became brown, and had suffered by decomposition; the former dissolved in water without any residuum, and when decomposed with carbonic acid, did not present the least appearance of sugar incapable of crystalization.

These two results agree with the results of Soubeiran, according to which, sugar combined with alkalies resists the effects of heat better than the pure solution of sugar.

When a concentrated solution of sugar lime is for some time exposed to the air, the sugar may also be separated unchanged; but hereby a peculiar phenomenon is observed. The mass gradually attracts carbonic acid from the air, without carbonate of lime being separated as a precipitate; at last the mass becomes transparent like a jelly, and under the air-pump assumes the appearance of a transparent gummy substance. On attempting to dissolve this mass in water, large quantities of carbonate of lime are separated; the same occurs when the moist, jelly-like mass is diluted, or heated, with water.

That a solution of sugar will decompose carbonate of lime, is a known fact, but these quantities are so small, that they cannot be compared with those found in this case. Whenever I tried to dissolve newly precipitated carbonate of lime in concentrated, or diluted, solutions of sugar, or of sugar lime, I always found that only a small portion of the fluid had been absorbed; when I introduced carbonic acid into a solution of sugar lime, a precipitate of carbonate of lime would form immediately.

Why, in the above mentioned case, when the absorption of carbonic acid proceeded very slowly, no carbonate of lime was separated, I am not able to explain; but the phenomenon is interesting enough to be examined more carefully.

Concentrated, or diluted, solutions of sugar lime, which have been a long time exposed to the air, generally become somewhat darker, but even when they assumed the color of white wine, I could never discover decomposed sugar. The color is undoubtedly produced by organic substances, which, introduced from without, have been decomposed by calcareous earths.

Effect of neutral Salts upon the pure solutions of Sugar.

When alkaline chlorides, neutral alkalies, alkaline sulphates, and

alkaline carbonates were brought in contact with solutions of sugar, no other phenomena appeared than those which are observed in pure solutions of sugar under different influences.

The salts, however, interfere with the crystalization of cane sugar, particularly chlorides, and it appears as if they entered into actual combinations with the sugar. Péligot pretends to have obtained a crystalized compound of common salt and of cane sugar, other chemists have not succeeded with this experiment. Mitscherlich does not admit of a combination of common salt with sugar. I have not attempted to produce such a compound, but have limited myself to discover how far these salts are injurious to the crystalization of sugar.

In a solution of sugar to which I added two per cent. in weight of common salt in *one* experiment, and, in another, the same quantity of chloride of calcium, I could, by no means, produce any crystalization. When the mass is dissolved in water, and treated cold with much bone-black it crystalizes again, but it then only contains very small quantities of these salts. Alkaline carbonates have the same effect. Saline sulphates and carbonates partially crystalize from a solution of sugar, to which they are added in considerable quantities; a portion of them, however, form a greasy mass with the sugar. When added in very small quantities, as much as two per cent., they injure the crystalization of the sugar, but not as much as the chloride.

Influence of substances containing Nitrogen upon a pure solution of Sugar.

According to our experience, the presence of nitrogeneous substances is an absolute condition to produce in the solution of sugar fermentation, either vinous, acetous, or mucous; no saccharine vegetable juice is deficient in this respect, for all are capable of fermentation under certain circumstances. This power of decomposing sugar by the so called fermentation, does not belong to any particular nitrogenous substance; but it has been observed that animal, as well as vegetable, albumen, casein, gluten, and generally the substances containing protein, can exert the same influence.

Another change remains to be mentioned here, which cane sugar undergoes through nitrogenous substances, and which must be of interest in the present case. H. Rose,* namely, has found that under the influence of fermenting substances, cane sugar, before the commencement of vinous fermentation, is transformed into another kind of sugar, namely, grape sugar,† and that cane sugar is not capable of immediate fermentation. It is very probable that not only the vinous fermentation is preceded by this change, but that all the other similar transformations of the cane sugar, are, in the same manner, preceded by a transformation into a kind of sugar capable of direct fermentation.

The general conditions of fermentation are a temperature above the

* Poggend. Ann. of Phys. and Chem. vol. li, p. 293.

† According to Ventzke, fruit sugar.

freezing point, to about 40° R. (122° Fahr.) and access of the atmospheric air to the substances which affect each other.*

Access of atmospheric air is not only a condition to produce vinous fermentation, but also to effect the so called mucous fermentation. Mucous fermentation is easily formed in the expressed juice of the sugar cane when the air has free access; when excluded, no change takes place.

This is the basis of Apert's method of preserving vegetable juices. Péligot received from Martinique, cane sugar in its original state; the fresh cane juice had been heated to a boiling heat, and put in bottles whilst hot—the bottles had then been waxed. When this juice is taken out of the bottles, a mucous fermentation soon takes place. A similar experiment has not yet been made with the juice of the beet. The conditions under which nitrogenous substances are capable of producing the spirituous, milky, or mucous, fermentations, have not yet been ascertained. Boutron and Frémy have made an important contribution to the knowledge of the circumstances under which the milky fermentation takes place, in a very interesting work.† This work was particularly interesting for me, as milk fermentation is one of those changes which the juice of the beet manifests most frequently.

In the beet root we find vegetable albumen, and a number of other substances containing nitrogen; of the latter it has not been ascertained whether they belong to the compounds containing protein, and if they are fit to effect changes like these. That cane juice and beet juice possess the qualities of fermentation, is a well known fact. The only thing to be ascertained is whether, among the nitrogenous substances, the quality of inducing a change belongs solely to the so called albumen.

Let us first examine the phenomena which appear in the juice of the beet. When exposed to the air, immediately after expression, it frequently turns mucous very soon; it undergoes the mucous as well as the spirituous fermentation. On examining this altered juice, we find lactic acid, mannite, a gummy mass, and sugar, which cannot be crystalized. The juice of the beet may be preserved for twelve hours and longer, without any material change, but when once the process of decomposition has commenced, it proceeds rapidly; the smallest part of fermenting beet juice mixed with fresh beet juice, induces a change in a few hours. The juice of beet from which, by boiling, a considerable part of the nitrogenous substances, have been removed, manifest almost the same qualities as fresh beet juice; when exposed to the air it undergoes mucous fermentation, when the juice contains much or little free alkali. When the alkalinity of the juice has been diminished by acids, sometimes a spirituous fermentation takes place; but if we take the juice, although containing alkali, and moisten with it bone-black, press this mass into a glass, and keep it in a favorable temperature, a short time will suffice to produce spirituous fermentation, but no other.

I attempted to observe these phenomena on a small scale, by means

* Berzelius' Chemistry, vol. viii.

† Ann. de Chim., Juillet, 1841, p. 257.

of the two nitrogenous substances, which I prepared from the precipitates of the beet juice with lime. By bringing a solution of sugar into contact with the calcareous substance, the liquid generally became weak, sour, and somewhat mucous, after a few days. Acid lactæ, and a gummy substance, which could be precipitated by spirits of wine, had formed; mannite I could not discover in these experiments. The substance insoluble in water, the albumen of the beet, brought in contact with a solution of sugar, induced similar changes, but not until after a greater lapse of time. The products were the same, a part of the albumen, before insoluble, was soluble, and could be precipitated by tannin. When the sugar solution was made weak by alkaline, and brought into contact with these substances, the alkalinity disappeared after a while, and the decomposition became the same as before. When I made the solution of sugar strongly alkaline, no change was observable for a length of time. In all these cases I observed that the cane sugar changed into another kind of sugar, and this before any signs of fermentation appeared. This change was very evident when I brought a solution of sugar of 10° R., to which I had added some of the calcareous substances, into free contact with the air, by means of a cylinder filled with glass, as before described. After a few hours all the cane sugar seemed to be transformed into another kind of sugar, without indicating the formation of any other products. Continuing this process for a sufficient time, the liquid at last became slimy, but not sour. In this case, the substances containing nitrogen, seem to operate in the same manner as in the formation of vinegar from wine. Acids, and principally mineral acids, can prevent the fermentation under these circumstances. By heating a solution of sugar, which contains nitrogenous substances, to boiling, or by boiling it for a long time, it does not lose its fermenting properties, as I have stated before: clarified beet juice ferments very easily. Beet juice which had been evaporated to 25° R., and had, therefore, been exposed for a long time to the action of the heat, changed completely when left alone in a bottle for some considerable time. Carbonic acid was generated, and forced the cork out of the bottle; after a fortnight the fermentation ceased, and it afterwards appeared, on examination, that neither spirits of wine, nor acids of any kind, had formed. The product was principally mannite, and a gummy mass which could be precipitated by spirits of wine in the watery solutions.

When bad cane sugar from the colonies is dissolved in water, and left to stand in a favorable temperature, it produces a phenomenon quite similar to that mentioned above, only that in this liquid I could find no mannite, undoubtedly because too much other sugar prevented its separation.

All these phenomena are the results of the influence of nitrogenous substances; wherever similar phenomena appear, such substances will be discovered. Substances containing nitrogen may produce effects different from those mentioned just now at a higher temperature, that is to say, in contact with boiling solutions of sugar, or at temperatures a little above the boiling point of water.

It is a known fact that when a concentrated solution of raw sugar

and one of loaf sugar is left for some time in a temperature of 110°, the raw sugar solution changes much more than that of refined sugar. The supposition that in this case a direct transformation is effected in the sugar, by the nitrogenous materials contained in the mass, is not improbable.

This opinion obtains confirmation from the following experiment: Take a simple solution of sugar, and a solution of the same sugar clarified with blood; boil both for the same length of time, and the clarified solution will soon become discolored, whilst the simple solution remains colorless. In every clarified solution of the sugar refiner, even where the purest sugar has been used, we find substances containing nitrogen, which can neither be precipitated through tannin, nor this reagent (the blood.) It is possible that the clarified solution may be free from these substances, when very fresh blood is used; this remains to be tried, for it is certain that the older, and the more impure the blood, and the more albumen is changed by putrefaction, or whatever else this decomposition may be called, the greater will be the quantity of nitrogenous matter contained in the clarified solution; nor is it unlikely that the albumen of the blood, during the process of clarifying, is, by the influence of the heat, so changed, that it either coagulates no more, or when coagulated, dissolves again.*

I obtained the same results when I mixed and boiled a pure solution of sugar with the calcareous substances, frequently alluded to. The solution became of a darker color, and the test by copper indicated the formation of another kind of sugar. In this case the substance containing nitrogen had evidently changed, for, on continuing the boiling for some time, lime water, indeed, produced a precipitate, but only a trifling one, whilst nitrate of mercury produced a very abundant precipitate; before boiling, the substance could be perfectly precipitated with lime.

The products which are formed in this decomposition of nitrogenous substances, I have examined no further. I should suppose that during this change, ammonia is generated and emitted, whilst the remainder of the elements combine to form acid products, and effect the same changes on the sugar as all acid substances do. The brown color of sirop is mainly attributable to such products of decomposition.

The behaviour of substances containing nitrogen, during ebulition, and at higher temperatures, as in concentrated solutions of sugar, has been but little examined as far as I know. Only a few substances, lime and albumen, have been observed under similar circumstances, and have been found to change. In these experiments, the substances came only in contact with water, and the temperature was consequently not much above 100° C.; at higher temperatures the behaviour will be probably somewhat different, because, in general, some of these bodies are decomposed with more or less facility, accordingly as their elements are grouped more or less densely.

From what has been said before, we may conclude that the nitrogenous substances of the beet, and probably those of the sugar cane, can exercise different influences every where at the common tem-

* See Berzelius Lernbrech der Chemie, vol. viii, page 792.

perature, when these juices are left to themselves, and exposed to the air; and further, by heat during the process of boiling.

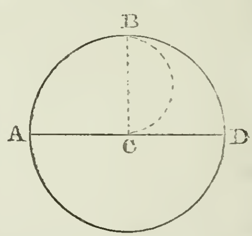
To be Continued.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On the Strength of Cylindrical Boilers. By Thos. W. Bakewell.

It is not my intention to prolong this discussion beyond a few remarks, on an unexpected denial by "E," in the October number of the Journal, of a proposition stated in my reply, (vol. vi, page 210.)

The estimate of the force to rupture, by the theory I advocate, is fair matter of dispute; but the proposition, above referred to, is the legitimate product of the received doctrine. In calculating the parting force, by the received theory, it is necessary either to suppose that the vessel containing the steam, possesses sufficient stiffness and strength to be unalterable in its shape, *independently* of any form which may give it this quality; or, what is the real state of the case, and the source of error, to overlook this circumstance altogether. Therefore, the transverse section, or diameter, determines the parting force, without regard to the form of the ends of the vessel on either side said diameter—that the direct force of the steam, perpendicular to the diameter, and such part only of the oblique forces as may be resolved into direct, are operative in parting the vessel at the diameter—and that the remaining forces derived from the oblique, being resolved into a direction parallel with the diameter, need not be taken into the estimate. The proposition made by me, presents the figure, or segment, of a boiler, A, B, D, C, attached at A and D, to a solid body, C. The substance of my averment, was, that by the received theory, the force to part at B, was half that exerted at A or D. "E." admits that the diameter governs at A and D, and that the whole force is sustained, one-half each, by A and D; but denies the applicability of the rule to the diameter, B, C, of the figure; or that the *half only* of the amount of force on A, D, is borne jointly and equally by B and C. Draw the semi-circle, as shown, on B, C, for the termination of *that* end of the figure, and let the line, B, C, be a tie bolt, considered sufficient to preserve the shape.



Can this change, in the form of one of the ends of the figure, vary the parting force by the steam at B? but the semi-circles on B, C, and on A, D, are similar, and under like conditions.

If it be said, the tie bolt, to preserve the shape, and perpendicular to the considered direction of rupture, lessen the strain at B, then, indeed, do we approximate in opinion; but as this admission cannot be looked for from "E," I maintain that the proposition is incontrovertible,—viz., that B, sustains half, and only half, of the force on diameter, B, C, in like manner with A D, as to their diameter. I wish it to be well noted, that the force to part at B, by the *received* and

rejected theories, is respectively as half the versed sine, C, B, to half the arc, A, B, D, and by raising the chord, A, D, parallel with itself, towards B, we can press the contending theories to their ultimata, and see whither they lead us; for the rule will hold till the chord, in advancing, obliterate the arc. I trust that "E" will not "jump to the conclusion," that I undervalue the facility with which he expresses himself in algebraic notation; but to those who see this subject as I do, his solutions fail in effect—wanting, as we conceive, that essential element to correctness—the consideration of the flexibility of material.

The preliminaries on which to found an equation are not agreed, and algebra cannot reason, or furnish ideas, although it afford a concise and convenient form of expressing them, be they correct, or erroneous.

Cincinnati, November 10th, 1843.

American manufacture of Wire Ropes for inclined planes, standing rigging, mines, tillers, &c. By John A. Rœbling, C. E.

The art of manufacturing ropes of *wire* is comparatively new. Numerous attempts have been made in Europe and here, and most of them have proved failures. A collection of parallel wires, bound together by wrappings, in the manner of a suspension cable, is no rope, and not fit for running, it can only be used for a stationary purpose. The first rigging made in England, was of this description. The difficulty in the formation of wire rope, arises from the unyielding nature of the material; iron fibres cannot be twisted like hemp, cotton, or woolen; their texture would be injured by the attempt. To remove this obstacle, some manufacturers have resorted to *annealing*, and thereby destroyed the most valuable properties of iron wire, viz., its great strength and elasticity.*

My first attempts in the manufacture of wire rope, were made four years ago; my intimacy with the construction of wire cable bridges, induced me to investigate this matter. The principles of my process differ from those of the English manufacturers—they are original and secured by patent. The novelty of my proceeding chiefly consists in the spiral laying of the wires around a common axis *without twisting the fibres;* and secondly, in subjecting the individual wires while thus laying to a uniform and forcible tension under all circumstances. By this method, the greatest strength is obtained by the least amount of material, and, at the same time, a high degree of pliability. Each

* By the term elasticity, I mean the property of wire to stretch and give when subjected to a strain, and to resume its former length after the strain ceases, without suffering a permanent elongation. The extent of elongation of iron is in proportion to the tension. In estimating the strength of a rope, the strain it has to support should never exceed the limit of elasticity. A permanent strain requires some more allowance.

The elongation of good wire of No. 14, 15, or 16, amounts, according to my own experiments, to 1-5000 of its length per ton per square inch. A strain of 15 tons upon a rope of 1 square inch section, and 1000 feet long, will produce an elongation of 3 feet. The limit of elasticity for working rope, I have assumed at 15 to 20 tons per square inch, according to the size and quality of the wire. A greater strain will produce permanent elongation, and if repeated, at last a rupture.

individual wire occupies exactly the same position throughout the length of a strand; another result of the precision and force applied in laying, is the close contact of the wires, which renders the admission of air and moisture impossible.

Three years ago I offered to the Board of Canal Commissioners, which was then in power in Pennsylvania, to put a wire rope of my manufacture on one of the planes of the Allegheny Portage Railroad, at my own risk and expense, the value of the rope to be paid in proportion as it rendered services equivalent to a hemp rope. This liberal offer, however, was rejected, and not considered until the present Board came into office. Last year I put three ropes, measuring, in the aggregate, 3400 feet, 4½ inches circumference, in operation on plane No. 3. Owing to the want of adhesion, I had, at the start, to contend with some difficulties. By means of a double groove on the receiving sheave, and a guide sheave placed back of it, which crosses the rope, and leads it from one groove to another, which improvements were added to the machinery last winter; I succeeded in doubling the adhesion. When, in unfavorable weather, there is delay and slipping on the other planes, the wire rope can at all times pull as heavy a load *without* a balance, as the engine is capable of hauling. The planes of the Portage Railroad require hemp rope of 8½ inches circumference, made of the best Russia, or Italian, hemp, and which cannot be trusted longer with safety than one season. They are frequently, from reasons of economy, continued 1¼ seasons; much, however, depends upon the weather and business. The unfavorable circumstances under which the wire rope had to work last year, affected it some; the wear of the whole of this season, however, is not perceptible, and its present condition promises a long duration. I am now manufacturing another wire rope of 5100 feet long, in four pieces, for plane No. 10.

The first rope of my make, 600 feet long, 3¼ inches circumference, has now been in successful operation two seasons, hauling section boats from the basin to the railroad at Johnstown. Two more were put to work last spring, at the new slips, at Hollidaysburg and Columbia. From my present experience, I may safely assert, that *wire rope* deserves the preference over *hemp rope* in all situations much exposed, and where great strength and durability is required.

By my process of manufacture, the same pliability is imparted to the rope which is proper to the wire itself. Paradoxical as this may appear, it is nevertheless a fact, and is easily explained. By pliability, is here understood the extent of flexure to which the rope, or wire, may be subjected, without producing a permanent bend; when released the rope must resume its former and straight position. To bend a rope requires force, and this force is in proportion to its areal section, *cæteris paribus*.

Well manufactured iron rope is *more* pliable than hemp rope of the same strength. I am manufacturing tillers of fine wire, capable of bearing 3000 lbs., and which ply around cylinders as small as four inches in diameter, and in which the wires are so compactly laid, that not the slightest shifting in their spiral position is to be observed. A

number of my tillers are in use on the Ohio and Mississippi. Such rope would be pliable enough for running rigging, and be of long duration.

I will here add a few remarks on the introduction of *standing wire rigging*, in place of *hemp rigging.* This subject has, for some years past, engaged the attention of the Navy Department of England and France, and the success which has attended the use of wire in place of hemp for shrouds and stays in the naval and commercial service of Great Britain, would, it appears, seem to warrant an attempt to test its utility in our national vessels.

Allow me to cite here a few remarks from the notes of Capt. Basil Hall, on a tour through Switzerland, and while examining the wire suspension bridge at Freiburg. He says, "attempts are now making, and will ere long succeed, to introduce wire rigging, which is stronger and better than *chain*, because less dependent on the accidental quality and careless manufacture of a single part. How strange it is, that the plan of making *wire bridges*, so successfully adopted in France, and elsewhere, should not have found favor enough in England to be fairly tried on a large scale. Freiburg bridge, 301 feet *wider* than Menai, at least equally strong, has cost only one-fifth of the money. I do not think wire will answer for running rope; but for standing rigging it may, I conceive, be most usefully substituted for hemp, for, with equal strength, experience shows it to be lighter."

The cables of suspension bridges are stationary, and will, when protected against oxidation, last an indefinite period. Standing rigging, when compared to running rope, is nearly stationary, and there is little wear but what arises from the direct strain, which, if supported by sufficient strength, will have no deteriorating effect. In comparing the two materials, wire and hemp for rigging, the state of preservation, and time of use should be considered. For instance, a hemp stay of a certain size, made of the best Italian hemp, will, when new, possess two-thirds of the strength of a wire stay of the same weight per foot; but let the two stays have been exposed, and served five years, then the strength of the hemp stay will be gone, while the wire stay will not show any perceptible reduction. In this case, of course, a common wear and tear is supposed.

The most prominent features of wire rigging, as compared to hemp rigging, are its great durability, less weight and size, less surface exposed to wind, less danger in time of action of being destroyed by shot. Another good quality of the wire rope is its great elasticity, which is quite sufficient to counteract the effect of a sudden jerk while a vessel is rolling heavily at sea. The elasticity of hemp rigging is only to be relied on to a very small extent; it will give and stretch a great deal, but not return.

A common objection of those not familiar with the nature of wire rope, is its supposed rapid destruction by oxidation, but no apprehension is less founded than this. Running wire rope, while in use, either in or out of water, in mines, or any other situation, will not even require the protection of oil, varnish, or tar; while at work it will rust no more than a rail, or a chain, in use; but when idle, oxi-

dation will affect it in proportion to the surface exposed. As, however, the process of laying is carried on with mathematical precision, by which the wires are brought into the closest contact, the assemblage of wires in form of a strand, present a solid rod, which will be no more subjected to rusting, than the link of a chain of the same size. The individual wires, as well as the strands and ropes, are coated with an excellent varnish during the manufacture. Wire rigging will require no other protection but oiling, or tarring, once or twice a season. Where elegance is an object, black or green paint may be used. Rigging made of zinced wires, and not painted, would present a most beautiful appearance, and be exempt from all rusting.

Wire rope can be spliced in the same manner as hemp rope. The attachment of wire shrouds to the sides of the vessel, and to the masthead, and their connexion with the rattlins, (which should also be of wire,) can be effected by the old method; the use of wire, however, will suggest some modifications better adapted to the material.

Some wire rigging has been manufactured in England, which simply consists of a collection of parallel wires bound together, and served over with hemp. These mixtures, as experience has proved in the case of tiller-ropes, are objectionable—the wire will rust inside of the hemp in spite of all protection by varnish; besides the cover of hemp, which adds nothing to the strength, is only an additional expense.

Iron is now gradually superseding wood in the construction of vessels, a complete revolution in ship building has already commenced in England. Although very expensive at first, iron ships will prove cheapest in the end. Are there any well founded objections to wire rigging, which assumes the same relation to hemp rigging, as wooden ships to iron ones? There are none. Why then not test this matter by encouraging those who are capable of bringing it to perfection? A number of iron vessels are now building for the naval and revenue service, which seem to offer appropriate occasions for the test of this matter.

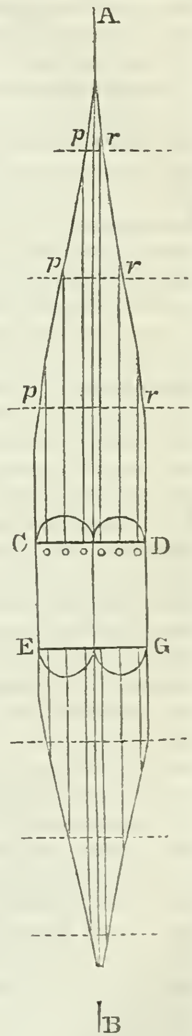
Saxonburg, Pa., September, 1843. Amer. Rail Road Journ.

The Forms of Ships.

The great importance of naval architecture induces us to return to the report of experiments conducted by a committee of the British Association for the Advancement of Science, which was read at their last meeting at Cork. The account copied into the last number of our *Journal*, from the *Athenæum*, was chiefly limited to the notice of the experiments themselves, and merely adverted casually to the deductions founded upon them, without describing the form of least resistance, which the committee recommend as the result of their five years' labors. We have since been supplied with a further account of Mr. Scott Russell's exposition, and, as the experiments have been more numerous, and have been conducted on a larger scale than any previously made on the subject, we think it desirable, in the absence

of the voluminous report of the committee and drawings, which may not be published for years, to state at least some of the results of these long-continued and costly experiments.

In Mr. Scott Russell's exposition of the labors of himself and Professor Robison, after mentioning minutely the mode in which they had conducted their experiments, and their results, he proceeded to describe the form of construction which they had determined to be the best, not only as offering the least resistance to motion through smooth water, but also as best adapted for rough seas. It is to be regretted, however, that in this, the most important part of his exposition, Mr. Russell was less explicit and not so minute as in describing the preliminary experiments. He stated facts, but did not explain the principles by which they were regulated, therefore it is difficult from one isolated form of construction, which was all he exhibited, to determine how far it is adapted to vessels of other sizes. He observed, that the great point which, in the first instance, was endeavored to be gained, was to get rid of the wave at the bow, which has the same effect in retarding a vessel as if it were immersed so much deeper in water. It was found that this object might be attained by lengthening the ship, and that whenever speed was required, there must be an absolute length without regard to breadth.



Mr. Russell having stated that each velocity has a corresponding form and dimension peculiar to that velocity, he exhibited the form of the light-water line of a steam vessel intended to be propelled with a velocity of 17 miles an hour, and explained the mode of constructing it. Suppose the breadth C D, of the vessel to be 25 feet, there must be set off forward from the greatest midship-section 120 feet, and for the after-part, 85 feet. To make room for the engines, there is no objection to putting in a piece in the middle of the vessel, called the middle-body, of equal width to the greatest midship section. On half the breadth of the vessel, fore and aft, describe the semicircles C, D, E, G. Divide the fore part, *o* A, into a given number of equal parts, and divide the semicircles also into the same number of parts; in the accompanying diagram, we have divided them into not more than four, for greater distinctness. Then draw lines parallel to the keel, A B, from the division *o, o, o,* of the semicircles to the cor-

responding divisions p, p, p, and r, r, r, of the keel, and the points where the lines intersect show the form of water-line required. The form thus attained, it will be observed, is very sharp both fore and aft, though the after part, or run, being shorter, is necessarily more full than the entrance of the vessel. This form is much opposed to the ordinary practice, inasmuch as the line is hollowed out, or partly concave, instead of being of the convex form, or full bow, which old ship-builders so much admire.

Having thus described the form of the light-water line, Mr. Russell promised to give the view he entertained of the principle on which the superiority of its construction depended; in this particular, however, he failed to make himself very clearly understood. He first alluded to the notions entertained of the manner in which the water is displaced by the motion of a vessel. It is commonly supposed, by ship-builders, that the water passes round the vessel; some imagine that the fluid is rolled under it; whilst, according to the French philosophers, the impact of water obeys the same laws as the impact of solid bodies, and the water is reflected from the bow at an angle equal to the angle of incidence. From the latter assumption they deduced that a round full bow is best adapted to meet with least resistance. It had been proved, however, in the course of these experiments, that the particles of water displaced by the bow of a vessel move into new places, that peculiar motions are given to them, and that they never return to their former positions. The motion of displacement, also, was found to be not confined to the vicinity of the vessel, but to have an extensive effect in a region anterior to the bow, and extending to a considerable distance on each side; and some time before the bow approaches a particle of water, the fluid has commenced moving. Viewing the sea as composed of innumerable verticle columns of water, the effect of the approach of a vessel is to produce greater pressure on one side of such columns than on the other, and water being, practically speaking, incompressible, the particles pressed against can move only in a vertical direction, and thus a heaping up of fluid is produced before the bow of the vessel, sometimes ranging as far as half its length. The next object the committee had in view was to examine the direction of the motion of the particles of water displaced by a vessel. It was found that when the form was that of least resistance, the motions of the particles of water were in semicircles; and that they deviated from that curve when the form departed from that of least resistance. It was also determined, that the replacement of the water as a vessel moved forward, takes place entirely from below. The result, therefore, to be attained, as appeared from these experiments, was to ascertain the form of the solid of least resistance, which would communicate these motions to the particles of water. In experiments on the forms of waves, conducted also at the expense of the British Association, it had been ascertained that the motion of water itself is that which the committee had endeavored to give to the water when ships pass through it. Thus it happened, that the form best adapted for least resistance in smooth water, being itself the form of the waves of the sea, the vessel of that shape moved through the sea with the

least motion and the least resistance. The consequence was, that in the course of these experiments it was found that a vessel built in the form of least resistance in smooth water, instead of being, as was formerly supposed, likely to be wet and uneasy in a rough sea, in fact passed through the waves without doing more than modifying their motion, and that in proportion as ships approach to the form of least resistance, they were dry, easy, and good steering boats. The concluding experiments were made on ships of 2000 tons, differently formed, and the same law which was found to prevail in smaller vessels was also followed in the large ships and in the roughest seas.

We have endeavored on the foregoing report, to give as intelligible an account of the deductions from the experiments on the form of ships as could be collected from Mr. Russell's exposition. It is evident, however, that there are many points of importance not sufficiently elucidated; and though the principle on which the advantages claimed for the wave form is attempted to be established as regards easiness of motion in a rough sea, the reason why that form is the one of least resistance in smooth water, is by no means clear.

It is a very difficult, and perhaps an impossible task to extract the pith from a voluminous mass of papers, calculations and drawings adapted to differing circumstances, so as to present, in a comparatively small compass, a satisfactory view of the whole; nevertheless, we wish to arrive at some fixed laws, and the principles on which they are founded. It appears that in all the experiments the object aimed at was to ascertain the form of least resistance in *cutting through* the water, and that no attention was bestowed on the form best adapted to cause the vessel to glide over the head-wave. The experiments, however, which were made a few years since on the Scotch canals with passenger boats, in which we believe Mr. Russell himself took part, show that the head-wave may be prevented by the boat being raised in the water by the oblique impact of its bow with the fluid.

Civ. Eng. and Arch. Jour.

Mechanics, Physics, and Chemistry.

Patent Case.—Winans vs. *The Boston and Providence R. R. Co.*

We are particularly indebted to B. R. Nichols, Esq., of Boston, Counsellor at Law, for furnishing the following synopsis of a recent patent case, in which his Honor Judge Story decided some points of interest to inventors and patentees in general.—Com. Pub.

An action in favor of Ross Winans against the Boston and Providence Rail Road Corporation was tried in the U. S. Circuit Court, before the Hon. Judge Story, at Boston, in November last, for a violation of a patent granted to Mr. Winans on the 20th October, 1831, "for an improvement in the construction of the axles, or bearings, of rail way or other wheeled carriages."

In the specification annexed to his patent, he states that he has invented an improvement in the construction of the axles, or bearings, of rail way or other wheeled carriages, in which, instead of forming the bearing under the body of the carriage and within the naves or

hubs of the wheels, there to sustain the weight of the load, he extends the axles out at each end, projecting beyond the naves to such a length as shall enable him to form them into gudgeons—the length and diameter of these gudgeons he regulates according to the load they are intended to sustain, and to other circumstances. In all cases, however, the value of his invention depends upon the gudgeons having their diameters as small as due attention to the strength required will allow. He then states various advantages in this mode of constructing axles and gudgeons, and that this improvement was exhibited by him in an experimental rail way in 1827, and put into practical operation under his direction on the Baltimore and Ohio, and Liverpool and Manchester rail ways, in the early part of 1829, in connexion with friction wheels, for which friction wheels a patent was granted him in October, 1828. That these gudgeons were exhibited by him in England in 1829, and were adopted there without his deriving any advantage therefrom, as by the laws of that country, he could not secure the invention by patent, after having publicly exhibited it.

He then states, that the object of the invention, and a practical demonstration of its utility having been shown, its application and adaptation to the different rail road carriages, burthen wagons, locomotive engines, &c., and to the different bearing boxes that may be preferred for different purposes, (either revolving or common,) will be evident and easy to any person acquainted with the building of rail way carriages. But to render it still more so, the following general directions and proportions are given, which he thinks will be found to be a near approximation to what will be required in practice. He then states the general size of the axles and gudgeons which he would recommend for a given weight of load—and that the axles extend through and beyond the naves of the wheels on each side far enough to go under and receive the side frame of the load-bed—on the four gudgeons thus formed, the carriage body rests by means of any hard metal bearings attached to the side pieces, which side pieces are so framed with the cross pieces of the bed as to go on the outside of the wheels, either over or under the gudgeons as convenience may require. The friction occasioned by the tendency to a lateral movement of the gudgeon is limited by causing the end cover of the bearing to meet the end of the gudgeon as near to the centre of action as possible. When the revolving box is used, this end is attained by forming the end perfectly square, and when the common box is used, by forming the end of the gudgeons convex or rounding. In consequence of the small extent of bearing surface, the bearing box should be made as hard as the use of the most favorable materials for that purpose would permit. He then speaks of oiling the gudgeons and of preventing the oil working out, by turning one or two small rings or grooves on a portion of the axle between the gudgeon and the nave of the wheel. He then states that he does not intend to claim all merely projecting axles beyond, or external to, the wheels—and alludes to several of a different construction, either having a single wheel, or having a separate axle for each wheel, or one made subsequent to his invention for a temporary object, and not effecting the

like purpose, and that his invention is sufficiently distinguished from others by the new and useful effect produced in manner aforesaid. He then sums up his claim as follows:

"I therefore declare, that the improvement or improvements, above explained and described, in diminishing the resistance to motion in wheeled carriages to be used on rail ways, which I claim as my own invention, is the extending the axles each way outside of a pair or pairs of wheels, far enough to form external gudgeons to receive the bearing box of the load body, and diminished as aforesaid, with a view to lessen the resistance of friction, as small as its situation, with the use of the most favorable metal for wear, will permit. Thus conveniently increasing the leverage of the wheels, without impairing their effective strength and durability."

The defendants pleaded the general issue, and filed a specification of the various grounds of defence on which they relied—and among others, that the invention claimed was not new, but was, before the supposed discovery thereof, described in various printed publications, especially in Edgeworth on roads and carriages, where he describes the Irish car, with outside bearings, the axle turning with the wheels.

The plaintiff admitted that carriages with *out side bearings*, were in use before his invention, but he contended that by the specification annexed to his patent, he claimed simply the *application* of such outside bearings with diminished journals to rail road carriages.

The Court, however, decided, first, that he did not claim the *application* merely to rail road carriages, as appears by the title of his patent and the first clause in his specification, and secondly, that if he claimed merely such application, it could not be allowed, for it has repeatedly been decided that the application of an old invention to a new purpose, without any new contrivance or machinery, was no ground for a patent; and that if a patent, under these circumstances, could be sustained at all, it must be for the new mode of construction and new machinery by which the old invention was so applied—which new construction and machinery must be particularly specified. Here the plaintiff claimed generally the extending the axles each way outside of a pair or pairs of wheels far enough to form external gudgeons, and diminished with a view to lessen the resistance of friction. It being admitted that such mode of constructing axles had been before used in other carriages, the mere application of the same to rail road carriages was no ground for a patent.

This point being decisive of the cause, the other points of defence, viz: that the plaintiff was not the original inventor even as applied to rail road carriages, and that if he had been, he had abandoned the same to the public, and that the same had been in use by others for more than two years prior to granting the patent, were not discussed or considered.

GLEANINGS FROM FOREIGN JOURNALS.—No. III.

On a Remarkable Photographic Process, by Sir John Herschel.—If nitrate of silver, specific gravity 1.200, be added to ferro-tartaric

acid, specific gravity 1.023, a precipitate falls, which is in great measure redissolved by a gentle heat, leaving a black sediment, which being cleared by subsidence, a liquid of a pale yellow color is obtained in which a further addition of the nitrate causes no turbidness. When the total quantity of the nitrated solution added amounts to about half the bulk of the ferro-tartaric acid, it is enough. The liquid so prepared does not alter by keeping in the dark. Spread on paper and exposed *wet* to the sunshine (partly shaded) for a few seconds, no impression seems to have been made, but by degrees, although withdrawn from the action of the light, it developes itself spontaneously, and at length becomes very intense. But if the paper be thoroughly dried in the dark, (in which state it is of a very pale greenish yellow color,) it possesses the singular property of receiving a dormant, or invisible picture; to produce which (if it be, for instance, an engraving that is to be copied,) from thirty seconds to a minute's exposure in the sunshine is requisite. It should not be continued too long, as not only is the ultimate effect less striking, but a picture begins to be *visibly* produced, which darkens spontaneously after it is withdrawn. But if the exposure be discontinued before this effect comes on, an invisible impression is the result, to develope which all that is necessary is to breathe upon it, when it immediately appears, and very speedily acquires an extraordinary intensity and sharpness as if by magic. Instead of the breath, it may be subject to the regulated action of aqueous vapor, by laying it in a blotting paper book, of which some of the outer leaves on both sides have been damped by holding it over warm water.

Barometric Compensating Pendulum.—In 1825, Dr. Robinson of Armagh, by comparing the rate of the transit clock of his observatory with the indications of the barometer, found that there was an effect decidedly due to the varying density of the air. To remedy this he attached a barometer tube to the pendulum, so adjusted as to increase the time of vibration, by removing a cylinder of mercury further from the axis of the pendulum, as much as the diminished density of the air would have increased the same time. A fall of 1.6 of an inch in the barometer last year, produced a perceptible change of arc in the pendulum.

Classification of Waves.—Mr. Scott Russell classifies waves into four orders: first, the wave of translation, solitary in its character; second, waves of oscillation; third, capillary waves; fourth, corpuscular waves; all these latter are gregarious. The velocity in the first order of waves is dependent on their height and the depth of the fluid; each particle of water describes a semi-circle or a semi-ellipse, and then comes to rest, all the particles throughout the depth suffer the same amount of horizontal translation. The velocity in the second order depends upon the length of the wave alone; the particles of water describe curves returning into themselves, there is no permanent translation and the effects extend to moderate depths only beneath the surface.

Determination of the index error of an astronomical circle.—Dr. Robinson of Armagh effects this as follows. Illuminate the lines in the focus of the telescope behind, so as to leave the field dark. The rays from the lines emerge parallel through the object glass, and if reflected back from a surface of mercury, will form an image of the lines which will be visible through the eye piece with the lines themselves. If the declination line be made to coincide with its image, the optical axis will be vertical. This method is found to be certain and so easy that the index correction is generally determined at Armagh, at the close of each night's work.

Self-registering Meteorological Instruments.—The electro-magnetic meteorological register, constructed for the Observatory of the British Association, is nearly complete. It records the indications of the barometer, the thermometer, and the psychrometer every half hour during day and night, and prints the results, in duplicate, on a sheet of paper in figures. It requires no attention for a week, during which time it registers 1,008 observations. Five minutes are sufficient to prepare the machine for another week's work, that is, to wind up the clock, to furnish the cylinders with fresh sheets of paper, and to recharge the small voltaic element. The range of each instrument is divided into 150 parts; that of the barometer comprises three inches, that of the thermometer includes all degrees of temperature between — 5° and + 95°, and the psychrometer has an equal range. The machine consists essentially of two distinct parts: the first is a regular clock, to which is attached all the requisite recurring movements; the second is a train, having an independent maintaining power, which is brought into action at irregular periods of time, by the contact of the plunging wires with the mercury of the instruments, as will be hereafter explained. The principal regularly recurring actions connected with the clock train are two: 1st. The plungers are gradually and regularly raised in the tubes of the instruments during five minutes, and are allowed to descend during one minute; 2nd. A type wheel, having at its circumference 15 figures, is caused to advance a step every two seconds, while another type wheel, having twelve spokes, but only ten figures, is caused to advance one step when the former completes a revolution. The complete revolution of the second type wheel is effected in six minutes, that is, in the same time occupied by the ascent and descent of the plungers. Thus every successive division of the range of an instrument corresponds with a different number presented by the two type wheels, the same division always corresponding with the same number. The two blanks of the second type wheel are presented during the return of the plungers, which occupies a minute, and during which time no observation is recorded. The breaking of the contact between the plunger and the mercury in an instrument, obviously takes place at a different position of the type wheels, according as the mercury is at a different elevation; if, therefore, the types be caused to make an impression at this moment, the degree of elevation of the mercury will be recorded. This end is thus effected. One

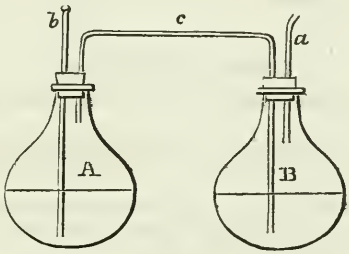
end of a conducting wire is connected with the mercury in the tube of the instrument, and the other end with the brass frame of the clock, which is in metallic communication with the plunger. In the course of this circuit an electro-magnet, and a single, very small, voltaic element are interposed. The electro-magnet is so placed as to act upon a small armature of soft iron connected with the detent of the second movement. So long as the plunger is in the mercury the armature remains attracted, but at the moment the plunger leaves the mercury the attraction ceases, and the release of the detent causes a hammer to strike the types, and impress them by means of black copying paper on the cylinder. The armature subsequently remains unattracted until the plunger descends. Immediately before it reascends, a piece of mechanism, connected with the clock movement, brings the armature into contact with the magnet, which remains there, in consequence of the recompletion of the circuit, until the contact is again broken.

Magnetic observations by the Antartic Expedition.—The following conclusions are drawn, by Sir John Herschel, from the observations made by Capt. Ross, and his officers, in the Antartic expedition: 1st. As great discordances are to be looked for, and must frequently be experienced in magnetic surveys conducted on land, as in those at sea, and even greater. In effect, the chief and worst cases of discordance occur in observations made on islands. 2nd. The general form of the curves of higher inclination in the southern hemisphere is much more analogous to that in the northern, than appears in M. Gauss' maps. 3rd. Capt. Ross' observations of intensity lead also to the conclusion of a much closer analogy between the two hemispheres, than M. Gauss' maps would appear to indicate. No higher intensity than 2.1 has been anywhere observed. 4th. In examining the observations of declination, particularly those which point out the course of the lines of 0° and 10° east, a more westerly position is indicated than that assigned by M. Gauss for the spot in which all the lines of declination unite.

Apjohn's formula for connecting the evaporating point, and the dew point.—Dr. Apjohn has applied three different experimental tests to this formula, and now gives a fourth. He shows that the elastic force of vapor in air, of any temperature, is connected, by a simple formula, with the temperature, an assumed volume of air, and the weight of vapor, of which the maximum of tension corresponds to the elastic force just referred to, in that volume of air; so that if the last named quantity be determined experimentally, the first named may be found. By passing moist air, of known volume and temperature, through suitable tubes containing chloride of calcium and asbestos, moistened with sulphuric acid, the weight of the vapor was ascertained, and the tension thence calculated was found to agree with that inferred from the formula, connecting the indications of the wet and dry bulb thermometers in the same air.

Method of determining the commercial value of alkalis, &c.—This method is proposed by Dr. Will, of Giessen:—"The apparatus by which this determination is effected, consists of two small glass

flasks, A and B, connected by the bent tube *c*, which passes through corks in the necks of the flasks. Into the flask A, is put the solution of the substance to be tried, and into B, is put concentrated sulphuric acid. Two other tubes pass through the corks in the flasks—the one, passing through the cork of A, dips below the surface of the solution, and is closed with a small piece of wax, while the one in B, is left open, and does not reach below the fluid contained in it. Suppose the flask A to contain a weighed quantity of a solution of a carbonate, then a known quantity of sulphuric acid is introduced into B, and the whole apparatus weighed; the tube *b*, being then closed with wax, if air be blown into *a*, a portion of the sulphuric acid passes over through the tube *c*, into the flask A, and comes in contact with the carbonate. The consequence is an evolution of carbonic acid, which must go through the concentrated sulphuric acid, and is thus made perfectly dry. When all the carbonate is decomposed, the piece of wax on the tube *b* is removed, and air sucked through the tube *a*, in order to remove all the carbonic acid. The apparatus is then to be weighed, and, from these data, the quantity of alkali combined with carbonic acid, may be easily calculated. The same method is applicable to the acids, particularly to vinegar, which was till now a very tedious, and, at the same time, a very inaccurate operation. Dr. Will considers that the value of soda, or potash, can be thus determined with much greater accuracy than according to the method of Descroizell, improved by Gay-Lussac."



Möser's images.—Mr. Hunt gives the following experiments upon these images:

"Three flat bottles, manufactured for Mr. Hunt's experiments on the influence of light on plants, were carefully prepared with three differently colored fluids. An intense solution of carmine in ammonia, which admitted the permeation of the red rays only; a strong solution of the sulphate of chromium, through which but a portion of the most refrangible red and the orange and yellow rays only passed; and the ammonia sulphate of copper, which absorbed all but the most refrangible portion of the spectrum. Thus were obtained the means of isolating, with a tolerable degree of purity, the calorific, the luminous, and the chemical spectra. Having several designs cut out of white paper, these were placed on copper plates, and being covered with the above bottles of fluids, placed in the sunshine. After remaining exposed for different periods at different times, from half an hour to three hours, they were brought from the light, and the plates

placed in the mercurial vapor box, and subjected to its influence. In no instance did any impression appear on the plates which were placed under the blue or yellow fluids, but in every case most decided impressions on those plates which were subjected to the influence of the red rays. Indeed, in some cases the impressions were beautifully visible without the use of mercurial vapor. It does, therefore, appear, when we take into consideration besides the above facts, also the fact which has been admitted, that artificial heat, at least, accelerates this molecular change, that an amount of evidence has been obtained in favor of the hypothesis of calorific disturbance, superior to the supposed evidences in favor of the absorption and radiation of any other solar emanation. From another series of experiments made with washed and unwashed plates, Mr. Hunt concluded that organic matter is not the cause of these images; but that the effect is due either to some disturbance of the latent caloric, which produces a molecular change, or to a thermo-electrical action, which it is difficult to understand. Had the effect been due, as M. Fizeau has stated, to slight layers of organic matter of a volatile nature, it appears natural to suppose that these mysterious images would have been found only on the very surfaces of the plates. Now, this is far from being the case. These images are often found to be impressed to a great depth into the metal. Mr. Hunt, in many cases, removed several surfaces of copper, and yet had been able to revive the images. He possessed copper plates rendered useless by the impressions, which he has in vain endeavored to remove."

Lunar Occultations.

Computed from the Elements published with the Occultation list of the United States Almanac.

Im. for Immersion, Em. for Emersion. These abbreviations in *Italics* refer to those Immersions and Emersions which take place on the Moon's dark limb. N. App. for Near Approach.

The angles are for *inverted image*, or as seen in an astronomical telescope, and reckoned from the Moon's North point and from its Vertex around through East, South, West, to North again. For direct vision add 180°.

JANUARY, 1844.

Day.	H'r.	Min.	Star's name.			Mag.	From North.	From Vertex.
1	9	11	*Im.*	32	Tauri,	6	221°	217°
1	10	23	Em				115	74
1	17	29	*Im.*	463	Bailey,	7	254	213
1	18	16	Em.				107	72
9	11	0	Im.	p^1	Leonis,	6	317	6
9	12	2	*Em.*				100	145
12	12	54	Im.	85	Virginis,	6	259	305
12	13	43	*Em.*				44	89
21	5	47	*Im.*		Bessel,	9	266	222
21	6	49	Em.				89	348
22	6	3	*Im.*		Bessel,	9	243	200
22	7	11	Em.				61	14
22	6	22	*Im.*		Bessel,	9	276	232
22	7	12	Em.				28	340
22	7	55	*Im.*		Bessel,	8	160	110
22	8	2	Em.				149	100

LUNAR OCCULTATIONS FOR JANUARY, 1844,—CONTINUED.

Day.	H'r.	Min.	Star's name.	Mag.	From North.	From Vertex.
22	13	29	*Im.* Bessel,	9	178	128
22	13	59	Em		135	85
23	4	1	*Im.* Bessel,	9	260	238
23	5	45	Em.		36	2
24	8	45	*Im.* 45 Piscium,	6	313	262
24	9	14	Em.		3	313
25	5	7	*Im.* Bessel,	8	297	293
25	5	56	Em.		4	343
25	7	1	*Im.* Bessel,	9	257	215
25	8	19	Em.		57	8
29	6	24	*Im.* v^1 Tauri,	5	249	73
29	7	56	Em.		291	65
29	7	14	*Im.* v^2 Tauri,	6	238	257
29	8	39	Em.		109	61
29	16	47	*Im.* τ Tauri,	5	196	153
29	16	58	Em.		170	128
31	3	58	*Im.* 759 Bailey,	6.7	288	356
31	4	53	Em.		56	112
31	6	57	*Im.* η Geminorum,	4.5	224	142
31	7	53	Em.		265	185
31	15	5	N.App.15 Gemin. ☽ S 0.′7	6		
FEBRUARY, 1844.						
2	5	32	*Im.* 3 Cancri,	6	261	314
2	6	25	Em.		107	161
5	15	52	Im. u Leonis,	6	272	239
5	16	54	*Em.*		149	107
5	16	29	Im. 57 Leonis,	7	308	256
5	17	37	*Em.*		112	66
6	17	46	Im. *B.* Virginis,	6	256	215
6	18	36	*Em.*		158	113
7	10	59	Im. q Virginis,	5.6	321	99
7	11	58	*Em.*		6	139
21	6	25	*Im.* Bessel,	9	171	121
21	6	41	Em.		145	96
22	5	51	*Im.* Bessel,	9	276	230
22	7	2	Em.		45	355
22	6	58	*Im.* 104 Piscium,	6.7	276	225
22	8	3	Em.		51	359
22	7	42	*Im.* Bessel,	9	301	249
22	8	48	Em.		29	336
22	9	33	*Im.* Bessel,	9	251	201
22	10	29	Em.		84	36
23	6	0	*Im.* Bessel,	9	289	243
23	7	21	Em.		62	10
23	9	30	*Im.* Bessel,	8	329	276
23	9	53	Em.		13	321
23	4	39	N.App. χ Arietis, ☽ N.1′.5	6		
24	10	43	*Im.* τ^2 Arietis,	7	233	180
24	11	33	Em.		120	71
24	11	36	*Im.* 65 Arietis,	6	220	170
24	12	13	Em.		134	87
25	4	50	Im. A^1 Tauri,	5	275	248
25	6	20	Em.		64	39
25	5	38	*Im.* A^2 Tauri,	6.7	304	304
25	6	46	Em.		38	3
25	10	27	*Im.* 463 Bailey,	7	222	166
25	11	9	Em.		142	88
27	12	22	*Im.* Q^2 Tauri,	6	209	154
27	12	39	Em.		176	121

METEOROLOGICAL OBSERVATIONS FOR SEPTEMBER, 1843.

Moon.	Days.	Therm. Sun Rise.	Therm. 2 P.M.	Baromtr. Sun Rise.	Baromtr. 2 P.M.	Wind. Direction.	Wind. Force.	Water Fallen in rain	State of the Weather, and Remarks.	
☾	1	74°	75°	29.90	29.94	E.	Moderate		Cloudy.	Cloudy
	2	67	78	29.95	29 95	NE.	do		Cloudy.	Cloudy.
	3	72	84	29.84	29.80	W.	do		Cloudy.	Lightly cloudy.
	4	74	86	29.74	29.75	SW.	do	.30	Par. cloudy.	Clear—rain.
	5	70	82	29.80	29.90	NE.	do		Cloudy.	Clear.
	6	70	75	30.05	30.05	NE.	do		Cloudy.	Cloudy.
	7	66	64	30.00	29.95	NE.	do	1.20	Rain.	Rain.
⊙	8	62	68	30.00	30.00	NE.	do		Cloudy.	Cloudy.
	9	62	68	29.90	29.95	NW.	do		Clear.	Clear
	10	56	62	30.10	30.09	N.	do		Cloudy.	Clear.
	11	50	52	29.90	29.90	NE.	do	1.52	Rain.	Rain.
	12	52	63	29.93	29.96	E.W.	do		Par. cloudy.	Flying clouds.
	13	52	66	30.06	30.10	NE.	do		Clear.	Par. cloudy.
	14	56	63	30.10	30 06	NE.	do	1.00	Clear.	Rain.
	15	71	76	29.80	29.72	S.SW.	Brisk		Cloudy.	Par. cloudy.
	16	67	76	29.82	29.88	W.	Calm		Clear.	
	17	72	68	29.90	29.95	W.	Moderate		Fog.	Clear.
	18	70	84	29.98	29.90	W.	Calm		Fog.	Clear.
	19	71	84	30.00	30.06	SW.	Moderate		Clear.	Clear.
	20	65	79	30.17	30.20	NE.SE	do		Clear.	Flying clouds.
	21	64	81	30.03	29.88	S.E.	Brisk		Clear.	Par. cloudy.
	22	71	72	29.88	29.88	W.E.	Calm		Par. Cloudy.	Clear.
⊗	23	61	74	29.91	29.88	S.	Moderate		Cloudy.	Clear.
	24	72	82	29.85	29.82	W.	do		Cloudy.	Clear.
	25	71	84	29.77	29.73	W.	Brisk		Clear.	Par. cloudy.
	26	70	63	29.65	29.68	E.	Moderate	.16	Rain—cloudy.	Rain.
	27	48	54	29.93	29.95	NW.	Brisk	.70	Cloudy.	Clear.
	28	40	59	30.07	30.06	W.	Moderate		Clear.	Lightly cloudy.
	29	50	65	30.03	29.99	SW.	do		Par. cloudy.	Clear.
☽	30	49	64	30.05	20.03	SE.	do		Par. Cloudy.	Clear.
		63.17	71.70	29.94	29.93			4.88		

Thermometer.		Barometer.	
Max. 86.00, on 4th. Min. 40.00, on 28th.	Mean, 67.435	Max. 30.20 on 20th. Min. 29.65 on 26th.	Mean29.935

OCTOBER, 1843.

Moon.	Days.	Therm. Sun Rise.	Therm. 2 P.M.	Baromtr. Sun Rise.	Baromtr. 2 P.M.	Wind. Direction.	Wind. Force.	Water Fallen in rain	State of the Weather, and Remarks.	
	1	57°	65°	29.79	29.67	SE.	Calm	.18	Rain.	Rain.
	2	62	70	29.58	29.58	W.	Brisk		Hazy.	Clear.
	3	56	60	29.56	29.51	W.	Blusteri'g		Clear—fly. clds.	Showery.
	4	48	59	29.46	29.70	W.	do	.03	Clear—fly. clds.	Clear.
	5	44	62	29.92	29.92	W.	Brisk		Clear.	Clear.
	6	48	68	29.88	29.80	S.	Calm		Clear.	Clear.
	7	58	62	29.67	29.56	E.	Moderate		Rain.	Rain.
⊙	8	74	58	29.45	29.43	W.	do	1.98	Rain.	Rain.
	9	41	54	29.68	29.54	SW.	do		Clear.	Clear.
	10	47	60	29.58	29 60	W.	Brisk.		Flying clouds.	
	11	46	62	29.75	29.75	W.	Calm		Clear.	Clear.
	12	52	68	29 75	29.72	SW.	Moderate		Cloudy.	Clear.
	13	44	55	29.86	29.78	SW.	do		Clear.	Clear.
	14	39	50	29.93	30.02	W.	Brisk		Clear.	Clear.
	15	40	52	30.09	30.03	SW.	Calm		Clear.	Cloudy.
☽	16	47	56	29.82	29.74	NE.	Moderate		Par. cloudy.	Cloudy.
	17	38	49	29.75	29.75	NE.	Brisk		Clear.	Cloudy.
	18	38	56	29.79	29.74	SW.	Moderate		Clear.	Clear.
	19	44	52	29.83	29.90	W.	Brisk		Clear.	Par. cloudy.
	20	38	62	29.92	29.95	SW.	do		Clear.	Clear.
	21	32	68	29.70	29.68	S.	Calm		Clear.	Clear.
	22	56	55	29.55	29.56	SW.	Moderate	.68	Clear—cloudy.	Rain.
⊗	23	48	45	29.80	29.83	NW.	Brisk		Clear.	
	24	36	50	30.00	29.95	W.	Moderate		Clear.	Clear.
	25	45	54	29.82	29.74	SW.	do		Cloudy.	Cloudy.
	26	44	45	29.92	29.85	NE.	do		Cloudy.	Cloudy.
	27	43	48	29.83	29.45	E.	do	.50	Rain.	Cloudy.
	28	37	49	29.97	29.86	NW.	do		Cloudy.	Clear.
☾	29	37	49	29.80	29.93	W.	Calm		Cloudy.	Clear.
	30	41	52	30.04	30.00	SW.NW.	Moderate		Cloudy.	Clear.
	31	32	43	30.10	30.13	NW.N.	do		Clear.	Clear.
		45.29	56.06	29.80	29.79			3.37		

Thermometer.		Barometer.	
Maximum 74.00 on 8th. Minimum 32.00 on 21st & 31st.	Me'n 50.675	Max. 30.13 on 31st. Min. 29.43 on 8th.	Mean, 29.795

JOURNAL

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FEBRUARY, 1844.

Civil Engineering.

Cost of Transportation on Railroads. By CHARLES ELLET, Jr., C.E.

(Continued from Page 8.)

Wear of Iron rails.—It was not my intention to deviate from the course which I had marked out as proper to be observed in the discussion and development of the important subject which I have attempted to exhibit, for the purpose of disposing of collateral points, or of refuting any objections that might be urged against my argument. But the matter presented in the December number of the Journal is of such deep interest to all concerned in the rail road cause, that I have been compelled to make frequent oral explanations and estimates, which could be more advantageously and more appropriately offered in their place in these articles. I propose, therefore, to recur briefly in the present paper, to the momentous question of the probable durability of the iron rails, and the pecuniary loss consequent on their destruction, for the purpose of presenting facts which it was my wish to postpone to a later period.

It is as impossible as it would be dishonest to attempt to promote the cause of internal improvement, or any division of that cause, by deceptive estimates or the expression of extravagant hopes. It is the duty of the engineer, as well as of the statesman, to look at things as they are, at this great system as it is. He must first recognize the weak points before he can hope to fortify them. If companies or their officers, fail to estimate their expenses truly, they will inevitably fail also in their great objects, and instead of bringing blessings and prosperity into the country, public improvements will continue to be, as they have hitherto frequently been, the bearers of private ruin and public dishonor.

The prevailing fault of all writers on rail road policy is that of yielding up their judgment to the dictation of their wishes, and exhibiting the facts as all desire them to be, and not as we find them. Hence the proverbial errors of companies and their agents, in undervalueing the first cost of their work; in over estimating its business, and underrating the cost of its maintenance. Their opinions are but the picture of their hopes, and rarely deductions from an extensive and systematic investigation, and a wide experience.

But we are now in pursuit of truth and shall endeavor to avoid this error.

The rail road system is new. It is not yet twenty-five years since the locomotive engine has been used with any decided success, and it is not fifteen years since its first employment on lines of general and extensive intercourse.

We have, nevertheless, much experience of the wear of iron rails; for a heavy trade—a trade vastly inferior to that of some of the canals of this country—is sufficient to produce great and obvious effects in a very brief space of time.

We cannot seek this experience, however, on the great rail ways recently finished in England. These carry but little freight. Their business is nearly confined to the conveyance of passengers; and though they really transport many tons of parcels and costly merchandize, and make a considerable show of business, the actual tonnage, compared with that of some of our important canals, is insignificant. Indeed, the public have not yet become accustomed to compare the actual weight of the trade which is transmitted along existing lines of rail roads, and that which passes noiselessly through the old canals, and there are consequently few who have yet formed a just conception of their relative magnitudes.

The *London and Birmingham* rail way has already cost about $30,000,000; and was graded with a view to the heaviest traffic; but the speed and accommodation which it offers are but slight compensation for the price of carriage at which they must be purchased. With all the labor bestowed upon this work; with all the outlay encountered to reduce the cost of transportation—the annual net tonnage upon it is not greater *than five or six weeks trade of the Schuylkill Navigation.*

The *Great Western* road has cost some $32,000,000. The net tonnage upon this line is still less than that upon the London and Birmingham. It does not reach 120,000 through tons per annum.

But the traffic upon these works, light as the tonnage is, has been sufficient, at the high velocity permitted, to produce great destruction.

The former commenced with two tracks of edge rail of 50 lbs. per yard, and wore much of it out before the line was finished.

The latter commenced with a 44 lb. bar between London and Maidenhead, and had rendered it unfit for safe service nearly a year ago. The still heavier iron which they are now using is not, of course, yet entirely destroyed. But before this time next year—if my calculations do not fail—I shall produce evidence in this Journal, that a

portion of these 75 lbs. bars, has also given way under less than 500,000 tons net.

At present, however, we will confine ourselves to past experience, and endeavor to ascertain from *that*, what sort of expectations we have a right to entertain for the future. The new English roads have added but little to our previous information on this head; but still we are not without a great deal of valuable experience; and it is the duty of those who seek for truth, and who seek to exhibit it to others, to profit by the best experience they can find.

In reference to the subject before us, we know,

1st. That some eight or ten of the rail roads of this country, have worn out the common half inch flat bar, with an average aggregate trade of 150,000 tons net, drawn by locomotive engines.

2d. The Camden and Amboy road has, in places, worn out an edge rail weighing about 40 lbs. per yard, with a trade considerably less than 400,000 tons net.

3d. The edge rail on the Columbia road, weighing 33 lbs. per yard, has not yet borne the passage of 350,000 tons on one track, and is nearly destroyed.

4th. On the Boston and Lowell road, a 36 lb. rail was so much injured, or so much weakened, as to need renewing and replacing before it had sustained the passage of 600,000 tons net.

5th. The Liverpool and Manchester road was opened in 1830. In 1835, the *first two tracks of edge rails*, weighing 35 lbs. per yard, were destroyed and renewed; and the trade was less than 600,000 tons net, on each track.

6th. In 1835, the Liverpool and Manchester Company relaid the portion of their road next to Liverpool with edge rails, weighing 50 lbs. per yard—or just five pounds per yard heavier than those of the Reading rail road. Before the close of 1840, these *new rails* (weighing, I say, 50 lbs. per yard,) were worn out, and taken up, and substituted by two other tracks of iron, weighing 64 lbs. per yard. These 50 lb. per yard rails were destroyed by about 700,000 tons net on each track. So that, in the brief space of nine years, this Company destroyed four successive single tracks of edge rails with an average net trade of about 300,000 tons per annum.

7th. The 64 lb. rails next introduced on this road, were found to be *too light*, and a 75 lb. pattern was substituted, which is now the adopted weight. These rails of 75 lbs. have already begun to give way at unsound places—the injury "showing itself chiefly in lamination and occasional splitting at the edges."

8th. The Stockton and Darlington road, considered as a single track, has been *ironed* with edge rails from six to eight times.

Business commenced on this line about the year 1825. In the year 1834, the trade had reached 338,248 tons. In 1840, it had attained the extraordinary limit of 803,784 tons, and up to the year 1842, there had passed along the work a net weight of nearly 6,500,000 tons. At that time six tracks had been destroyed and taken up and replaced, besides the rails that each time were introduced, before an entire change of form was resolved on. How many tracks this patching

may have amounted to, it is probably impossible now to ascertain. *The cars on this road are very light, and the velocity but six miles per hour.*

It is probable that each track of this road has sustained nearly 1,000,000 tons; and with such cars, and at such a moderate speed, it is not improbable that a 50 lb. bar would sustain from 1,200,000 to 1,500,000 tons.

9th. The London and Birmingham 50 lb. iron which was destroyed before the work was finished, sustained about 350,000 tons, on each track. The velocity here was, however, exceedingly great, and the cars unusually heavy.

10th. The net tonnage on the Great Western road, which destroyed the 44 lb. iron, did not reach 300,000 tons of freight and passengers per track. The engines and cars are still heavier than those of the London and Birmingham road, and the average speed 25 miles per hour.

Now, these are facts; and this, whatever it is worth, is *experience.* The intelligent reader must judge from the facts, whether or not, the cost of renewing iron ought to be regarded as one of the current expenses, or as a thing so extraordinary as to require to be excluded from the annual charges altogether, and added, as is now the universal custom, from year to year, to the cost of the road.

But the rapid destruction of iron under the action of a heavy trade, and the measure which, in the December number, I have assigned to its durability on the Reading road, where the velocity is from ten to fifteen miles per hour, is now but faintly denied; or, if denied at all, only by inexperienced parties, and in anonymous communications.

A new view is accordingly taken of the subject, and the important question arises to determine the amount of loss to the company consequent on the destruction of the iron. I mean to offer no conjectures on this head either, but refer to known and admitted facts, as a guide to my conclusions.

I find in the last report of the Boston and Lowell rail road company—the only company in this country, which has renewed a considerable portion of a track of edge rails in one year, and published the cost,—the following charge:

"For labor and sundry materials, in taking up twenty miles of track laid with 36 lb. rails, and replacing it by rails of 56 lbs. per yard, exclusive of the cost of rail iron, $34,162 09." The year before the expenditure for this object was $14,608, so that for changing 25¾ miles of edge rail, the company incurred an expense of $48,770, or $1,900 per mile.

There are seventy-one tons of rails in a mile of the track of the Reading rail road, and the cost of taking up the old iron and putting down new, is, therefore, $1900 for 71 tons = per ton, $26.75

A ton of new iron delivered in Philadelphia, will cost, under the present tariff, $60.00

The old iron is supposed to be worth, along the line, per ton, about 25.00

Difference between the value of new iron in Philadelphia and old iron on the ground, per ton,		$ 35.00

The cost of changing the iron track of the road will then be as follows:

Seventy-one tons of iron, taken up and put down, at $ 26.75		$ 1900
Difference between seventy-one tons of new iron bought, at $ 60,	$ 4260	2485
And seventy-one tons of old iron sold at $ 25	1775	
Seventy-one tons of new iron transported to, and distributed along the line, at $ 5		355
Cost per mile of changing iron,		$ 4740

This sum of $4740 will be the amount due to the trade which will destroy the iron, or render it unfit for safe usage. I know of no iron which has yet withstood the action of a million tons; and I know of no iron of 50 lbs. or less, that is likely to resist that weight. If we consider the rails of the Reading Road to be capable of that effort, then we shall have 4¾ mills per ton per mile for the value of the iron destroyed by each ton of coal descending the line—or 41½ cents per ton for the whole distance of 94 miles. By adopting the rates of speed of the Stockton and Darlington Road, it is probable that the cost of the iron could be brought down to 50 cents per ton, or near that limit; but if the company adopt the heavy cars, (7½ tons when loaded) and powerful engines, and heavy trains now contemplated, and continue the high velocity now permitted, the destruction of iron will probably be scarcely compensated for by seventy-five cents per ton. This is a calculation from such data as we are able to obtain. But was there ever a calculation of such work, which was not exceeded by the practical result? One of the data assumes that there will be as many tons of iron to sell, as were originally bought. But the weight will not hold out. It is useless to inquire why; yet we cannot spread 70,000 bars of iron along a road 100 miles in length, and beat them and roll them for one or two years, and then collect it all again. This is a practical difficulty which must always be encountered under such circumstance. The calculation assumes that it will all be collected; and, besides, that the 140,000 bolts, and the 70,000 chairs to be distributed and replaced, can likewise be found again.

Many visionary estimates have been made on this head, by parties of little experience in the handling of heavy materials, and in the performance of mechanical work; but the following practical facts are a great deal more forcible, and will be found to furnish data which can be applied with much more certainty than any speculative estimate whatever.

The *South Carolina* rail road was opened in the year 1833; the trade averages about 25,000 tons. In the semi-annual report for December 31st, 1838, five years after the completion of the work, we find the following:—" deduct the following expenditures, as being rather for permanent improvement than current expenses, viz:

Machinery,	$ 26,888 12
Spikes,	4,582 34
New rail iron,	3,940 00 &c.

This hint, to the experienced reader, is symptomatic of the contents of the next report, (June 30th, 1839,) from which I extract the following:

"Amount paid for rail iron in Charleston,	\$371,679 12	
Less old iron sold and unsold,	92,902 27	
		\$278,776 85
Cost of transportation of the same on the road, and laying down, including spikes,		74,400 00
Net cost of new iron,		\$353,176 85

Here we perceive that the entire sales of the old iron (when it was all disposed of, it yielded precisely \$92,325 71,) exceeded the cost of putting the new rail in the track, but by some \$18,000, while the net cost of the new iron, after deducting the proceeds of sales was \$353,-176. Such is in fact what is to be expected. The old iron will barely pay for putting down the new, and the loss to the company will be about equal to the cost of the new iron delivered at the sea-port.

A writer in the Railroad Journal proposes a scheme for the Reading rail road company *to make money*, by procuring rails free of duty, and selling the old material, after it has been worn out, with the advantages of the duty.

The operation was conducted under precisely those circumstances on the South Carolina road; but the above balance will show that the speculation did not turn out so well in that case. Indeed I have known many instances in which the iron has been renewed, but I have never heard of a company, here or abroad, that found the speculation a profitable one.

In the accounts of the South Carolina road, the new iron is charged to "permanent improvements," (the old iron lasted *five* years,) and the company recommenced with augmented capital.

I have but one word to add in reference to the durability of iron rails subjected to the action of a trade like that of the Schuylkill. I have already stated that if the Reading rail road company expect to obtain the whole trade of the canal, they must prepare for the entire renewal of a single track every year; and I now add, *if the company carry* 500,000 *tons of coal during the present year*, as they now propose to do, the new iron cannot be put down, before that now on the track will be so nearly destroyed as to be unsafe.

It is understood that this company has recently obtained an additional loan of \$1,000,000. With this it is proposed to stock and equip the line, and procure the additional track, and prepare for the conveyance of the whole trade of the Schuylkill.

I therefore advance this additional proposition. After this money is expended, and the company shall have put themselves, by its aid, in the position which they seek to occupy, they will neither, in the first place, be able to carry more than *half the tonnage* of the Schuylkill, and, in the second place, if they succeed in obtaining half the tonnage, they will not be able to engage vigorously in the business of 1845, without a *new loan* of a million of dollars; and, finally, if they continue to operate through the present and the next year, they can-

not engage in the business of 1846, without another loan of at least one million. In short, it is *impossible for them to carry the Schuylkill coal trade, without borrowing one million of dollars per annum.* And when they cease borrowing they must cease carrying. I now dismiss the consideration of a road, which, in my opinion, was most unwisely commenced—which has been prosecuted in folly, and which can only terminate in disaster. On this result I desire to rest my claim to the public confidence.

Additional application of the formula.—In the November number of the Journal, I offered a formula for the computation of the annual expenses of lines of rail way, and exhibited its application and agreement with the actual results on seventeen of the most important roads in the country.

The greatest deviation of that formula from the actual result was 12 per cent., which occurred in the case of the Baltimore and Ohio rail road for the year 1841.

In speaking of the deviations, I added these words: "It will probably be seen, on some future occasion, that those roads which now exhibit expenses above the formula, will fall below it for other years; a remark which is applicable *to the Boston and Lowell, Baltimore and Ohio, and South Carolina roads.*" Since the publication of that article, I have received through the politeness of Mr. Latrobe, the able engineer of the Baltimore and Ohio rail road, the report of the operations on that work, for the year 1843, together with some valuable manuscript details, of which I hope to make useful application in the further prosecution of my present study. I am also indebted to Charles S. Storrow, Esq., the valuable superintendent of the Boston and Lowell road, for similar statistics in relation to the excellent, and I believe, prosperous work under his charge, in anticipation of the publication of the report. I have also received from Mr. Storrow, similar information relating to his line, for the year 1841, which I had not before obtained, and from the report of the Baltimore and Ohio rail road company, I find the facts necessary for the application of the formula also to the Baltimore and Washington road for the year 1843.

These results have all been procured since the publication of the formula; and I therefore proceed to test it by making the application to those lines.

It will be recollected that I offered, in the first place, a formula for the determination of the expenses for a *new line*, viz:

$$\frac{24N}{100} + \frac{9T}{1000} + \frac{7P}{1000} + 300\,h.$$

And in the second place, a rule for the computation of the expenses of maintaining an old road, or road which had been opened more than four years, viz:

$$\frac{27.5N}{100} + \frac{14T}{1000} + \frac{7P}{1000} + 500\,h.$$

In both expressions N stands for the number of miles run by the locomotive engines; T for the *tons net* conveyed one mile; P for the

number of passengers conveyed one mile, and h for the length of the road, in miles.

In applying the formula to the Baltimore and Ohio road, it is to be borne in mind, that of the 178 miles in use for the year 1843, but 82 miles were opened previous to 1842, and that the whole of the remaining 96 miles is *new road.*

The result of the application to these several lines is exhibited in the three following tables:

TABLE.

Name of Road.	Year.	Length in miles.	Grades.	Miles run by trains.	Through tonnage.	Through travel.	Actual expenses.	Calculated expenses.	Error per cent.
Bost'n & Lowell,	1841	26	10	125,296	90,113	170,057	$119,469	$111,207	
Bost'n & Lowell,	1842	26	10	143,607	93,927	179,819	131,012	119,409	
Bost'n & Lowell,	1843	26	10	134,982	114,711	176,537	109,367	124,004	
Aggregate for these three years,				403,285	298,751	526,413	359,848	354,620	—$1\frac{1}{4}$

It will be recollected that I anticipated, in the November number, that subsequent results would be more favorable to the Boston and Lowell Road, than that of 1842. We here find it so. In 1842, the formula fell $11,603, or nine per cent. *below* the actual expenses. In 1843 the calculated expenses rise $14,637 *above* the actual expenses. But my remark in the December number should be recollected in these comparisons:—"The formula exhibits what it was intended to show—the average for a number of years." And hence, we have another test. The aggregate expenses on the Boston and Lowell Road for three years are, as we observe by the table, $359,848. The calculated expenses $354,620. This is surely close enough.

Again, we will take the Baltimore and Ohio Road, for the year 1843, for the purpose of an additional application.

TABLE.

Name of Road.	Year.	Length in miles.	Grades.	Miles run by trains.	Through tonnage.	Through travel.	Actual expenses.	Calculated expenses.	Error per cent.
Balt. and Ohio,	1841	82	$82\frac{1}{2}$	299,617	44,477	34,380	$220,135	$192,925	
Balt. and Ohio,	1843	178	$82\frac{1}{2}$	509,765	39,519	33,670	287,153	322,075	
Aggregate expenses for two years,							507,288	515,000	$1\frac{1}{2}$

I have taken no notice of operations on this work for the year 1842,

because during that year the line was opened, in parts, from Harper's Ferry to Cumberland.

The application for the year 1841, gave a result of \$27,210 *below* the actual expenses. I stated at the time that the subsequent expenses would be likely to fall *below* the calculated expenses. We accordingly find the result for the next year comes \$34,000 below the formula. Here, then, is another, and most conclusive, confirmation of the correctness of the formula, and of the principles on which it is founded. If we take the *sum* of the expenses for the two years, we find the calculation \$515,000, and the *fact* \$507,288.

But we have yet a third case: the Baltimore and Ohio Railroad report for 1843, exhibits, as has been stated, the results on the Baltimore and Washington Road, likewise for that year. These, together with those of 1841 and 1842, are presented in the following

TABLE.

Name of Road.	Year.	Length in miles.	Gr'de in feet.	Miles run.	Thro'h tonnae.	Thro'h travel.	Actual expenses.	Calculat'd expenses.	Error pr. cent.
Balt. & Wash.	1841-2	30½		91,428	27,369	114,260	\$ 73,684	76,166	
Balt. & Wash.	1843	30½		96,716	26,470	86,880	68,866	71,676	4

Here is an agreement within 4 per cent.

When I presented this formula in the November number of the Journal, and exhibited its application to seventeen lines of railway, I stated that these seventeen lines *were all the roads for which I had been able to collect the statistical information necessary for the application.* I had written to many companies, and had generally been supplied with the facts required, and which were not given in their reports. In some instances, however, they were unable to furnish the information which I needed; in two instances I received no reply to my letter; and in one—and I am happy to say one instance *only*—the officer declined making the affairs of the company public.

Since then the three companies above named have published their reports; and *they are the only reports for the year* 1843, which I have yet received. These reports add confirmation to the previous proof. Still, I advance the formula as an approximation only, which I hope, with the aid of my professional friends, and future facts, so to modify and improve, as to render its application general and certain. It is the expression of the true LAW; but the *constants* are to be built up by multiplied facts, until there can no longer be room to doubt its indications.

I have endeavored, so far, to conform to the method which modern science points out as proper to be pursued in practical inquiries. Much injury has been inflicted on the great cause of internal improvement, and especially of railroad improvement, by the erroneous opinions of enthusiastic, but unwise, advocates. But a new order of things has grown up, and a new system of enquiry is rapidly

gaining ground. The seed of true principles have been sown, and the roots have struck deep into the soil of this country. Under the control of these principles, and the direction of cool and honest advocates, the railroad cause will take fresh growth, and flourish with a vigor and heathfulness which it has not yet exhibited. Some visionary and extravagant projects, which are now bearing heavy upon it, will sink under the pressure of their own weight, and serve, even in their ruins, as salutary guides for the future.

During the transition, TRUTH will be for a time obscured, and possibly borne down; but it cannot be overcome. It is sustained by a power which is invincible. Truth makes no compromise of principle—yields nothing for the sake of present popularity—contributes nothing to the cause of public deception—and moves fearlessly, surely, and, in the end, all powerfully, to its mark.

[NOTE.—In the January number of the Journal, I offered an estimate of the probable expenses on the Reading Railroad for the year 1843, in anticipation of the publication of any facts on that subject—assuming the travel at 40,000 passengers, and the trade at 250,000 tons. This estimate was $265,000. I regret to find, on perusing the last report, that the company have not thought it expedient to publish their expenses for the *whole year;* but have preferred to exclude the last month, along with the heavy bills which the close of the year usually brings with it. The expenses published, for eleven months, amount to $221,060 89. I should have been exceedingly gratified to know the amount of expenses for the whole year.

The indebtedness of the company since the date of the previous report of January 1, 1843, has been increased,	$ 1,252,659
The receipts for the first eleven months of the year, amount to	385,195
Aggregate expenditure for eleven months,	$ 1,637,854

A statement of the *items* which have consumed this enormous sum would certainly be read with interest and instruction; and it is greatly to be regretted, that at this particular period, when the public are exceedingly anxious for truth and information, the directors have deemed it imprudent to publish it.]

NOTE.—The writer has expressed his opinions on an important subject without reserve, or concealment; should his *facts* be publicly disputed, or conflicting facts be presented, by any of his professional brethren, he trusts that they will have the consideration to do it over their own signatures—that he may have the guarantee of a name for the facts which *they* contribute. He will be found as frank in correcting his errors, if he has committed any, as he is sincere in the expression of his opinions.

To be Continued.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Herron's Trellis Railway Superstructure.

For the information of such of our readers as feel interested in the details of railway construction, we give room below for two documents relating to the experiment made with Herron's Trellis Superstructure, upon the Baltimore and Susquehanna Railway, in the suburbs of Baltimore. The length of the trellis track is about one-eighth of a mile; it lies partly upon an embankment, and partly in a sidehill cut; it is curved horizontally upon radii of 477, and 716 feet, with a short tangent between the curves, whilst its profile shows a grade of 84 feet to the mile.

Document No. I, consists of a letter addressed by Charles Howard, President of the Baltimore and Susquehanna Railroad Company, to James Herron, Civil Engineer, the portion in brackets being added by the latter. Document No. II, is a letter addressed to the President above mentioned, by D. C. H. Bordley, Superintendent of the road.

Com. Pub.

No. I.

In reply to your favor of the 11th inst., I take pleasure in handing you the enclosed report from Mr. Bordley, the Superintendent of our road, to whom I referred your letter. His statements of any facts may be implicitly relied on. The present condition of your track speaks for itself; and it may, at any time, be examined by any person who will take the trouble to visit the depot.

Coinciding as I do entirely in the opinions expressed by Mr. Bordley, it is unnecessary for me to reply to your questions. To do so would be merely to repeat what he has said; and I therefore refer you to his answers, as being those which I should give. For the information of those who are not informed of the circumstances, I will, however, explain how it is that we have not had an opportunity of subjecting your track to the test of bearing the daily passage of locomotives at high rates of speed. The track laid by us under your directions, and according to your plan of construction, is 672 feet in length, in the vicinity of our principal tonnage depot, to and from which locomotives occasionally pass with their trains; but the cars are most generally taken over this part of our track by horse power. On the other hand, the whole of your track is laid in a short curve, and has, of course, been much more liable to be thrown out of adjustment than if in a straight line, or curve of greater radius. [The curvature is in part 12° deflection to a 100 feet, and in part 8° to a 100 feet; the grade is also 84 feet to the mile. So that scientific engineers may judge of the severity of the test to which this track has been subjected from the centrifugal force of the trains, which are usually checked upon this steep gradient, by the brakes, and carried down to the depot in detachments. It is also worthy of remark, that contracted as is the curvature, and steep the grade, the engines and cars have never yet ran off of it. As a test of stability it has certainly been subjected to much rougher usage in its present position than it would have suffered on any other part of the road; of which any one

would be convinced by observing the straining of the horses, and surging of the engines, in dragging the heavily loaded cars up this steep grade, and through so contracted a curve.]

The cost of repairs generally includes that of the labor required in consequence of the subsidence and washing of new embankments, of the filling up of drains, &c., as well as that employed in adjusting the track. I cannot, therefore, say what is the cost solely of keeping an ordinary track in proper adjustment, independent of the other items; neither would our experience authorize me to assert that a track constructed upon your plan, would require no expense to keep it in adjustment where heavy locomotives, with large trains, might be daily passing over it with ordinary velocity; but I am convinced that it would cost less by fifty dollars per mile per annum, to keep such a track in order, than one of any other description with which I am acquainted, and the difference might be still greater. [The repairs on the road last year averaged two hundred and twelve dollars per mile, and as the repairs of the embankment, &c., of the trellis track has averaged only four dollars per mile for more than three years, it follows that the actual saving was at the rate of two hundred and eight dollars per mile per annum. But allowing fifty dollars per mile for clearing ditches, and repairs of embankments, which Mr. Howard, in a subsequent conversation, admits to be more than sufficient for these objects; or with incidental repairs to a trellis track, say sixty-two dollars per mile, it follows that if the whole road were laid with a trellis track of kyanized timber, there would result a saving to the company, on the repairs of the track, of one hundred and fifty dollars per mile; and action and reaction being equal, a similar saving would be effected in the wear of machinery, making the sum saved three hundred dollars per mile; which, on seventy miles, is twenty-one thousand dollars per annum, a sum which is equal to six per cent. on three hundred and fifty thousand dollars, exclusive of the saving in increase of traction, from the evenness of the track, and the increased comfort in traveling.]

It is unnecessary for me to do more than allude to the advantage which the continuous bearing of the rail gives to your track, over one in which no string pieces are used. The saving made by the former in the wear and tear of machinery, and in the power required to draw a given load is considerable.

In conclusion, I have no hesitation in expressing the opinion, that if the wood work be protected from decay, a track laid on your plan would be decidedly superior to any other of which I have any knowledge.

Office of the Balt. & Susq. R. R. Co.,
Baltimore, December 15th, 1843.

No. II.

The following are answers to Mr. Herron's questions:

1st. Herron's railway track has been laid on the Baltimore and Susquehanna Railroad three years and two months, (since October, 1840.)

2nd. Its condition is good; I can see no alteration since it was "first finished," except over a culvert that was newly built and filled over about the time the track was laid; this was raised once at a cost perhaps of *one dollar and fifty cents,* and it is at this time slightly sunken.

3rd. I do not think a track of ordinary construction would have retained its curvature and evenness of surface under the same circumstances.

4th. None of the iron fastenings have been removed, driven, or adjusted since it was first laid.

5th. The wrought iron chairs at the joints of the rails have held the ends of the bars securely, joined them evenly, and allowed the bars to contract and expand. I think them an improvement on the common chairs.

6th. I have observed no endwise movement of the rails upon the track.

7th. The track has required *no* adjustment, or raising, except as above mentioned, in answer to question 2nd.

8th. There has been no spreading of the track; the rails have maintained a regular parallelism, and also the degree of curvature first given to them.

9th. The track has been found equally adapted to horse power, and locomotive engines. I do not perceive that it possesses any material advantage over a track laid in the usual way, as regards the horse path; the trellis pieces being sawed to an even thickness, the track will require less filling to afford an even surface.

10th. I do not consider the covering of the trellis work, by the ballasting, sufficient to preserve the timber from decay materially; but it adds to the stability of the track *very much,* and will preserve it from fire.

12th. It is my opinion that a road constructed on the trellis plan of *kyanized timber,* would be a very durable structure, and would require but little expensive repairs for a number of years; but whenever it had to be renewed, or repaired extensively, would be found more expensive than one laid in the usual way.

13th. From the opportunity I have had of observing the working of the trellis track, I do, upon the whole, consider it greatly superior to the railway tracks in general use, at least, a great majority of them; I would be reluctant to pronounce it superior to *any other,* unless I could first see it tested by running locomotives on it at the usual speed; from the position of this track it has never been possible to do it. I have no reason to think, however, that the trellis track would, under any circumstances, prove *inferior to any track,* until a renewal of timber was found necessary; and this would be at very long intervals, if it was kyanized.

I have not attempted to answer the 11th question, (relative to the comparative expense of the trellis, and other railway superstructures) because I have no knowledge of what the construction of the track cost on this road, nor have I a knowledge of the cost of tracks on any other roads, by which I could make a comparison.

I am very favorably inclined to Mr. Herron's track; the excellence of its surface, both *winter* and summer, speaks much in its praise, and I feel sure that a road made on his plan would prove smooth and pleasant, and would *save* in the item of "*wear and tear of machinery.*"

Belvidere Depot, December 11th, 1843.

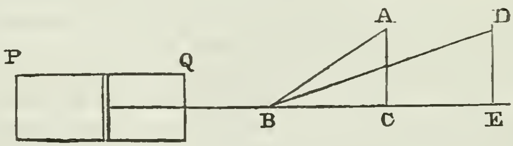
The relative efficiency of Long and Short Connecting Rods, considered in the exposition of crank and connecting rod motion. By H. F. Clifford.

The subject of the following paper is one of great importance to the practical mechanic; and as we have never yet seen any satisfactory solution of this long disputed question, we have endeavored to draw such conclusions from the investigation of the theory of crank and connecting rod motion as we feel convinced will set at rest all previous doubts concerning the comparative advantages of long and short connecting rods. With a given force in the direction of the piston, our object in the present investigation is to ascertain the best means of obtaining the greatest amount of that force in the direction of rotation, and thus render friction as small as possible; in other words, whether is a short or long connecting rod the more effectual method for fulfilling the conditions of our proposed inquiry?

We shall first show that if F be the original force exerted by the piston rod of a steam engine along its own axis, that there is more of that force transmitted in *the direction* of the long rod than the short one.

Let P Q, Fig. 1, be a cylinder with piston, and let the piston rod exert a force F, at the point B, where the rods B A, B D, connect it respectively to the cranks A C, D E.

Fig. 1.



Let A B make an angle (ϕ) with the horizon.
B D — (θ) —

The resolved part of F $\begin{cases} \text{in the direction of A B} = F \cos\phi. \\ \quad — \quad \text{B D} = F \cos\theta. \end{cases}$

Now the magnitude of the force in either direction depends on the cosines of the angles, which the respective rods A B, B D, make with the horizon, and since $\cos\phi$ and $\cos\theta$ become a maximum when ϕ and $\theta = o$. it follows the smaller the angle the larger the numerical value of the cosine, and since θ is considerably less than ϕ, the long rod has evidently more of the resolved part of F in its direction than the short one.

Again—

The resolved part of F $\begin{cases} \text{in the direction of A C} = F \sin \phi. \\ \quad — \qquad\qquad\quad \text{D E} = F \sin \theta. \end{cases}$

The magnitude of the forces in this case depends upon the sines of the angles, and since the larger the angle the greater the sine, the resolved part of F in A C, is much greater than that in D E; in other words, the pressure into the centre, or friction in the axle, is more in the short than in the long rod.

Having proved then that there is more force in the *direction* of the long rod, we now proceed to show that *the resolved part of the force in* B A, and B D, *in the* DIRECTION OF ROTATION, is greater in the case of the long than the short rod; or,

Proposition. To find the part of the force exerted by the piston rod of a steam engine which is perpendicular to the crank, in any given position of the fly.

Let E A, Fig. 2, be the piston rod, the direction of which produced is supposed to pass through the centre of the fly C; A B, the connecting rod; C B, the crank; B T D, the tangent at B.

Let C B $= a$, A B $= b$, A C B $= \theta$, B D $= x$, A D $= z$.

$\angle$ A C D $= \phi$, $\angle$ the tangent makes with the connecting rod A B.

The resolved part of F in B A $= F \cos$ B A C.

$$= F \cos (\text{A D B} + \text{A B D.})$$

$$= F \cos \left(\phi + \frac{\pi}{2} - \theta\right)$$

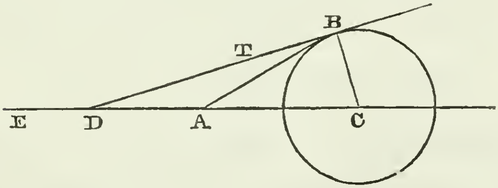
$$= F \sin (\theta - \phi)$$

$$= f \text{ suppose.}$$

The resolved part of F in B D $= f \cos \phi$.

$$= F \cos \phi \sin (\theta - \phi) \qquad \text{A*}$$

Fig. 2.



* The solution of this equation is rather intricate, as we have to express the value of F in B D, in terms of the known quantities θ, a, and b; but, as it is desirable to know the result, we give the working.

$$\text{Now } \cos \phi = \frac{b^2 + x^2 - z^2}{2bx}$$

$$x = \text{B D} = \text{B C} \tan \theta = a \tan \theta.$$

$$\frac{z}{\text{A B}} = \frac{\sin \phi}{\sin \text{A D B}} = \frac{\sin \phi}{\sin \left(\frac{\pi}{2} - \theta\right)} = \frac{\sin \phi.}{\cos \theta.}$$

$$\therefore z = b \frac{\sin \phi}{\cos \theta} = b \sin. \phi \sec. \theta$$

By substitution in equation 1, we have

In investigating equation A, it is evident that the smaller the angle ϕ the greater the force in B D, and the longer the rod A B, the smaller the angle it makes with the tangent, and thus we have more of the resolved part of the force in B A, in the direction of rotation in the long rod, *à fortiori*, how much more have we of the original force F, transmitted by the piston in the direction of rotation in the case of the long than the short rod.

There is, however, a small arc in the crank's orbit, in which the

Fig. 3.

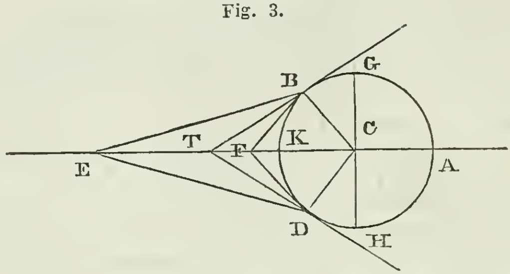
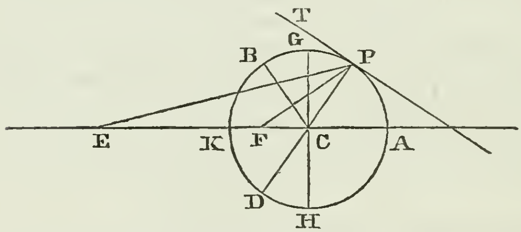


Fig. 4.



$$\text{Cos. } \phi = \frac{b^2 + a^2 \tan.^2 \theta - b^2 \sin.^2 \phi \sec.^2 \theta.}{2ab \tan. \theta}$$

$$\therefore 2\,ab \tan. \theta \cos. \phi = b^2 + a^2 \tan.^2 \theta - b^2 \sec.^2 \theta\,(1 - \cos.^2 \phi.)$$
$$\therefore b^2 \cos.^2 \phi \sec.^2 \theta - 2ab \tan. \theta \cos. \phi = (b^2 - a^2) \tan.^2 \theta.$$

Dividing by $b^2 \sec.^2 \theta$ and putting $\frac{a}{b} = 2m$, we have
$$\text{Cos.}^2 \phi - 2\,m \sin. 2\,\theta \cos. \phi = (1 - 4\,m^2) \sin.^2 \theta$$

Completing the quadratic and extracting the root $\Big\}$ $\cos. \phi - m \sin. 2\,\theta = \pm \sin \theta \sqrt{1 - 4\,m^2 \sin.^2 \theta}.$

Now the positive sign must be taken in order that cos. ϕ may be always possible.

$$\therefore \text{Cos. } \phi = m \sin. 2\,\theta + \sin. \theta \sqrt{1 - 4\,m^2 \sin.^2 \theta},$$

And $\sin. \phi = \sqrt{\cos.^2 \theta - 4\,m \sin.^2 \theta\,(m \cos. 2\,\theta + \cos. \theta) \sqrt{1 - 4\,m^2 \sin.^2 \theta}}.$

Let X = the resolved part of f, in B E,

then from equation A, $X = F \cos \phi \sin. (\theta - \phi.)$
$$= F \sin. \theta \cos.^2 \phi - F \cos. \theta \sin. \phi \cos. \phi.$$

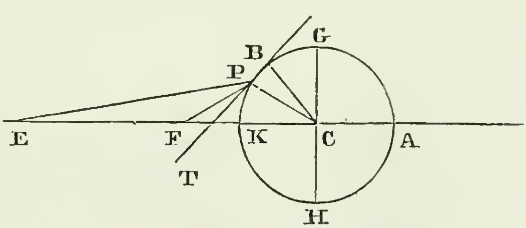
Putting for sin. ϕ and cos. ϕ their respective values, $X = F \sin. 3\,\theta \Big\{ 1 + 4\,m$

$(m \cos. 2\,\theta + \cos. \theta \sqrt{1 - 4\,m^2 \sin.^2 \theta)} \Big\} - F \cos. \theta \sin. \theta\,(2\,m \cos. \theta +$

$\sqrt{1 - 4\,m^2 \sin.^2 \theta)} \sqrt{\cos.^2 \theta - 4\,m \sin.^2 \theta\,(m \cos. 2\,\theta + \cos. \theta \sqrt{1 - 4\,m^2 \sin.^2 \theta}},$
which is the required equation.

short rod possesses an advantage, for let E B,F B, be respectively a long and short connecting rod, A G H, the fly G C H, perpendicular to A E, and let the crank (in Fig. 3) be in such a position that B T, the tangent, bisects the ∠ between the rods; let D be the point corresponding to B on the other side of E A, then the points B D, will evidently lie between G and K, and R and H. Let C P (in Figs. 4 & 5) represent the other position of the crank, and let P T be the tangent at P. First suppose the forces exerted by the connecting rods in their *own directions* to be equal, then it is clear (in Fig. 3) their resolved parts in the tangent will be equal, since ∠ E B T = ∠ F B T. Now from Fig. 5, it will be seen, that while the crank moves from B to K and from K to D, the short rod makes a smaller angle with the tangent than the long one, consequently, through this arc, the short one possesses an advantage; but, on the other hand, in Fig. 4, while the crank moves from A to B, and by parity of reasoning, from D to A, the long connecting rod makes the smaller angle. Hence, if we suppose the forces exerted by the rods in their own directions to be equal, the long rod is preferable, since in a whole revolution of the crank, it has the advantage through the arc D A B, which is > arc B K D, through which the shorter one has the advantage. But the forces exerted by the rods in their own directions are not equal, since if F be the force exerted by the piston F cos P E F, the force in the direction of the long rod is always greater than F cos P F C, the force in the direction of the shorter one, except when P coincides with A or K, when they are equal, and thus the superiority of the long rod in the entire orbit in *the transmission of rotary force*, has been satisfactorily demonstrated. Lastly, since the resolved part which produces rotation is greater in the long than the short rod, the resolved part perpendicular to this direction, or tending to the centre of the fly, is less in the long than the short rod; and this resolved part produces friction on the axis of the fly, which is the chief thing to be guarded against.

Fig. 5.



It is this trifling advantage possessed by the short rod that has induced several clever practical mechanics, with whom we are acquainted, to argue in favor of its superiority; but, whilst we agree with them, that it has the property of pressing at a more favorable angle during the progress of the crank through a very small arc, they must not forget the gradual increase and decrease of the force exerted by the piston on either side of the dead power point R, the*

* The circumstance of the piston's motion not being uniform is also in our favor, since the force exerted varies from zero to a maximum, as the piston travels from K to G and from K to H; and whilst this fact renders the advantage spoken of still more trifling, we have the long rod exercising the superiority at a time when the piston's exertion is a maximum.

inequality of the forces in their own directions, and that, moreover, this alleged superiority lasts only during a very limited portion of the crank's entire revolution.

Theoretically speaking then, there is no limit to the length of the connecting rod of a steam engine, but in practice, we are generally confined for space in the erection of machinery; still from the preceding analysis, we should endeavor to make it as long as we conveniently can, in order to obtain the greatest amount of rotary force, and thus render friction as little as possible. This subject might be practically illustrated, by taking a steam cylinder, furnished with the usual appendages, and connecting the piston rod end to the crank with a rod fitted with a long eye, or slot, so that the length of the rod could be adjusted at pleasure. On the crank shaft put a small drum, and suspend a heavy weight, that has to be wound up over it. By comparing the work done in a given time with the same amount of steam from the boiler, (at an equal pressure in either case,) it will be found that the result of the experiment, if accurately performed, will fully attest the superiority of the long rod, as shown in our theoretical deductions.

Civ. Eng. & Arch. Journ.

The Screw Propeller—Smith's Patent.

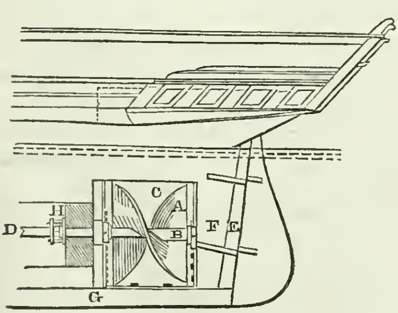
The complete success which has attended the application of the screw for the propulsion of vessels by steam, in every instance, induces us this week to lay before our readers some particulars connected therewith, and the performances of some of the ships which have during the past four years been fitted with it. Hitherto the vessels to which the screw has been applied have been of moderate tonnage, and it became a question, much canvassed among nautical and scientific men, whether it would have sufficient power to answer the expectations of the inventor in ships of extraordinary size and burthen; but the trial trip of the *Great Northern* down the river, on the 11th inst., when she accomplished ten and a half miles per hour without using any sails, has completely set the matter at rest, and proved the efficiency of the screw propeller for vessels of every size and description—and it is remarkable, that, although the propeller that has been applied to this monster ship is smaller in proportion to her tonnage than any other that has been yet fitted, her rate of speed under steam has surpassed the most sanguine expectations of all who have witnessed her performances.

The screw originally introduced into the *Archimedes* (the vessel on which the first really practical trial was made) consisted of one entire turn 8 feet in length and 7 feet in diameter; this, however, being found too large for the steam-power to drive with requisite velocity, was gradually reduced to 5 feet 9 inches—subsequently it was divided into two half turns, which reduced it to half its length, while the superfices of the screw remained the same. Various propellers tried by Mr. Smith in small experimental boats, and subsequently in

the *Archimedes*, have shown that the most effective form is one entire turn of the thread; this, however, for the sake of compactness, may be divided into two half, three thirds, or even four quarter turns, which renders the propeller considerably shorter, while its useful effect is in no way diminished.

The angle which the thread should make with the shaft has been closely experimented on, and it has been found that an inclination varying from sixty to seventy degrees at the circumference has produced the best result. The circumstances, however, which would determine the precise angle between the two, as also its diameter, depend on the form and description of vessel to be propelled—for instance, if a tug or heavily laden vessel, the latter angle would be most suitable; but in a vessel of fine lines and light draught of water, the former would be best adapted in order to obtain a high rate of speed.

On starting the vessel in a dead calm, a column of water in the shape of an inverted cone may be seen thrown astern of the ship, from which it is inferred that the whole force of the screw is propellant in the direct line of its axis, while that of the paddle-wheels is partially lost in entering the water and raising it considerably above the level on leaving it, which produces the swell so much complained of in river steamers. The position of the screw is in the dead wood immediately before the rudder, the keel being continued along underneath it. One great advantage of the screw being placed in this position is, the transferring the whole weight of the propelling apparatus from the top sides of a vessel to the lowest part of the hull; and in the *Great Britain* (of 3600 tons), recently launched at Bristol, it has been ascertained that in applying the screw, instead of paddle-wheels, as originally intended, 100 tons of superabundant weight have been removed from her upper works—a circumstance of immense importance to the safety of the ship when laboring in a heavy sea. The annexed engraving shows more clearly the principle and situation of the screw propeller:—



DESCRIPTION.

A—The thread or worm of the screw.
B—Screw shaft.
C—The opening or space in dead wood.
D—Propeller shaft.
E—Solid stern-post.
F—Dead wood of the vessel.
G—Iron or metal knees, which carry the propeller.
H—Stuffing box, through which the shaft passes to the engine.

As the speed obtained by the Archimedean screw is, perhaps, one of the most important points under consideration, we will now pro-

ceed to give some particulars of the performances of those ships which have already adopted it.

Summary of the Performances of the "Archimedes."

(237 tons, 70-horse power.)

May 14, 1839.—Made the passage from Gravesend to Portsmouth in twenty-one hours, against a strong westerly breeze.

October, 1839.—Beat the Hon. East India Company's steamer *Queen*, of 220-horse power, upwards of three quarters of a mile in a run of eight miles.

April 18, 1840.—She was ordered to Dover for the purpose of trying her powers with her Majesty's packets at that station, on which occasion the fastest of them, the *Widgeon*, was beaten nine minutes between Dover and Calais, and five minutes on the return trip, which was done in one hour and fifty-three minutes—being the quickest passage ever made between England and France, by fourteen minutes. The Dover boats vary from 70 to 90 tons less, their engines from 5-horse to 10-horse power more, and the draught of water from four to five feet less than the *Archimedes*.

June 5.—Ran from Milford to Liverpool (200 miles) in nineteen and a half hours. Surpassed the swiftest boats on the Mersey; and on one occasion beat to windward up that crowded river with as much facility as an ordinary sailing ship. From Liverpool to the Isle of Man she beat the *Mona's Isle* packet (a vessel of superior power) nearly two hours—running the distance of seventy miles in seven hours and fifteen minutes.

August 1840.—She performed the passage from Plymouth to Oporto in sixty-eight and a half hours, and the homeward trip between those places in eighty-eight hours, with wind a-head nearly the whole distance.

November, 1841.—During her passage from Bristol to London, made headway at the rate of three and a half knots per hour against a tremendous sea, whilst other steamers of much larger power bore up, as shown by the pilot's certificate.

"Princess Royal."

(Steam-tug boat, on the screw principle, 45-horse power.)

After beating the fastest of that class of boats on the Tyne, performed a passage from that river to Brighton in forty-eight and a half hours, a distance of nearly 400 miles. She has towed out of Shoreham Harbor, at one time, two large brigs, against the wind, and tide setting in, at the rate of four miles per hour; on another occasion, towed out a brig, which carried away both topmasts immediately the steamer had cast off. This little vessel, also, went to sea with comparative ease, whilst the *Dart* steamer, of 120-horse power, was more than half an hour before she could accomplish the same object, owing to the sea and tide running at the time.

"The Great Northern."—Extracts from her Log.

Sunday, Dec. 25, 1842.—8h. 5m. Weighed anchor in Cowes Roads, and put the ship on her course for London, under steam and canvass.

9 50 a. m. Massey's log put overboard ; revolution per minute of engine, 18 ; rate per common log, 10 knots ; Massey's log, $10\frac{1}{4}$ do. 11 50 a. m. Stopped engines abreast of the Ower's light-ship, and disconnected the screw ; ship put on her course up channel, with sails only. Noon. Fresh breezes and cloudy. 2 30 p. m. Abreast of Beachy Head ; ship brought to her course. 5 5 p. m. Massey's log hauled in. (Note—The distance run from the Ower's light-ship, by chart, sixty-six nautical miles, in five hours and two minutes.) Hove to, and fired guns for a pilot. 5 50 p. m. Took pilot on board ; wind increasing. 7 50 p. m. Anchored in the Downs in eight fathoms water.

Monday, Dec. 26. –4 a. m. The wind blowing a gale, down royal and top-gallant yards. 8 50. Changed pilots. Noon. Gale increasing, and a great number of ships running for the Downs. Midnight. Weather about the same.

Tuesday, Dec. 27.—9 a. m. Gale suddenly moderated ; steam raised to assist in getting the anchor. 11 40 a. m. Got under weigh, and proceeded through the Downs, setting fore and aft sail, wind being directly a-head. 5 17 p. m. Abreast of the Nore light. 9 p. m. Anchored nearly opposite the Chapman beacon.

Wednesday, Dec. 28.—7 a. m. Got under weigh, steaming only ; wind a-head. 9 5 a. m. Stopped off Gravesend and changed pilots. 9 17 a. m. Started for London against ebb tide and light wind. 12 a. m. Abreast of Woolwich. 12 20 p. m. Arrived at Blackwall, and moored ship, having stopped six minutes in Longreach to adjust machinery, thus accomplishing the run from Gravesend to Blackwall (twenty-one miles) in two hours and fifty-seven minutes, the mean rate of the tide being taken at two miles per hour.

Since the *Great Northern's* arrival at Blackwall, considerable improvement has been effected in her engines, by Messrs. Miller and Ravenhill, which was satisfactorily shown in her trials on the 11th instant, in the presence of a large party of gentlemen connected with science and the shipping interests. We subjoin the following particulars of her dimensions .—

	Ft.	In.		Ft.	In.
Extreme length	247	0	Diameter of screw	11	0
Extreme breadth	37	0	Length of screw	5	10
Length bet. perpendic.	222	0	Pitch of ditto	14	0
Depth in hold	26	5	Length of mainmast	90	0
Draught of water	18	0	Length of mainyard	79	0
Diameter of cylinders	5	8	Diameter of ditto	1	$10\frac{1}{2}$
Length of stroke	4	6	Length of foremast	83	0
Immersed area of mid sec	542	0	Length of mizenmast	61	0
Area of screw propeller	75	0	Spread of canvass	6700 yards.	

Burthen 1515 tons.

It will be seen from the above extracts from her log, that the *Archimedes*, though not built for extreme speed, but more to show the practicability of uniting sailing and steaming qualities in one vessel, has succeeded in beating many vessels of superior power, built expressly for steaming. Her utmost speed under steam alone was nine

and a quarter knots; with steam and sails combined, under the most favorable circumstances, it was upwards of eleven knots. This is particularly worthy of consideration, as showing the utility of a moderate steam-power on board sailing vessels in case of calms or contrary winds, while the expenditure of fuel need not be resorted to during favorable winds merely for the trifling gain above stated. Upon twenty out of thirty-two points of the compass a ship would be able to dispense with her steam power altogether.

The great superiority of the screw is most apparent in causing the ship immediately to answer her helm; the stream of water thrown astern by its action keeps the helm steadily amidships, and the slightest movement of the wheel is sufficient to govern her. In turning about, the effect of the screw is surprising; on the *Archimedes* putting the tiller hard over, she performs a complete circle in two and a half minutes, and two and three quarter minutes the second—the rudder acting as a drag on the stern, it takes longer time to make a second circle than the first, yet the space occupied is less, until the vessel seems to turn on a pivot—an entirely new manœuvre in navigation.

Lond. Mining Journ.

Historical notices of Screw Propelling.

(Ante) 1727. In the "Machines et Inventions approuvées par l' Academie Royal des Sciences depuis 1727, jusqu' an 1731," there is described a machine by one Duquet, for forcing a vessel *up a river against the current by* MEANS OF THE SCREW.

1768. In a French work by Paucton, on the "Theory of the Screw of Archimedes," the author proposes to substitute for the common oar an instrument which he calls a "*pterophore*," *composed of the circumvolution of the thread of a screw round a cylinder.*

1792. Baron Seguier states that some time before this date, there was to be seen at the Conservatoire des Arts et des Metiers of Paris, the plan of a steamboat which was to be propelled by a *screw fixed in, or connected with, the rudder.* Jobard's Bulletin, 1842.

1802. A propeller was successfully applied by John Shorter, to H. M. S. Doncaster, at Gibraltar, which Mr. Galloway, on the authority of Mr. Napier, states, was on the principle of the screw. Galloway's Appendix to Tredgold, p. 4.

1804. In "Memoire sur les Bateaux á Vapeur des Etats Unis d' Amerique," by Marestier, it is mentioned that a vessel had been propelled, or proposed to be propelled, by means of a "*helicoidal surface*," nearly as long as the vessel, enclosed in a channel running fore and aft.

1816. Mr. Robertson Buchanan in his Treatise on Propelling Vessels by Steam, says, "Experiments have been made on a kind of screw, but this I believe, after a trial on a considerable scale in America, was rejected. Some mechanics, however, still think favorably of it, and suppose that if a screw of only one revolution were used, it

would be better than where a longer thread is employed." The American experiments here alluded to, are, no doubt, those spoken of by Marestier.

1818. About this time an English engineer, of the name of Brain, settled in Belgium, is said to have announced that he had discovered a new means of propelling vessels, namely, "*by screwing them through the water.*" Jobard.

1819. October 1, a Mr. Whytock announced (Edin. Phil. Journal, vol. ii, p. 19,) that he had five or six years before made various experiments in propelling boats by means of two screws; *the lines of which were obtained from the circumvolution of a thread round a cylinder.* The screws would seem to have been applied one on each side of the boat; but Mr. Whytock's description is so worded as to leave this in some doubt.

Mr. Scott, of Ormiston, proposed to employ a screw working in a cylinder entirely immersed in the water. Thompson's Annals, vol. xi, p. 438.

1824. August 9; Mr. Jacob Perkins patented "certain improvements in propelling vessels," which consisted in fixing at the stern two sets of revolving oars, having their centre of rotation *above the water*, and entering it obliquely at the same time on opposite sides of the rudder, and after each revolution leaving the water at the sides opposite to the respective entrances.

1825. Mr. Samuel Brown applied to an experimental boat a propeller on the principle of the screw, consisting of two flat blades affixed to a longitudinal shaft at an angle of 45°, and placed in the *bow* of the boat.

1826. Nov. 18; Mr. Bennet Woodcroft, of Manchester, patented certain "improvements in wheels and paddles for propelling boats," the nature of which improvements is thus described by Mr. Woodcroft in his specification: "I declare that my said invention consists in a *spiral* paddle, made of wood, metal, or any other suitable material of the following construction, by the revolution of which boats, or other vessels may be propelled on water; that is to say, a spiral worm-blade, or screw, coiled round a shaft, or cylinder, of any convenient length and diameter, in such form that the angle of inclination, which the worm makes with the axis of the cylinder, continually decreases, and the pitch, or distance, between the coils, or revolutions of the spiral, continually increases throughout the whole length of the shaft, or cylinder, upon which the spiral is formed, the effect of which construction is as follows: The spiral paddle being made to rotate in the water, when the commencement of the spiral blade, or that part of it which forms the greatest angle with the shaft, acts upon the water, it gives to it an impetus, or motion, towards the back end of the paddle, thus creating a current in the direction of the spiral. If this current were to reach the succeeding, or following, parts of the spiral paddle, before those parts take their action upon the water, such following parts would move in, or keep pace only with the current, and would, therefore, meet little or no resistance from the receding water, and a part, or whole, of their action would

be lost, or without effect; but by previously elongating the pitch of the spiral, each successive part of the spiral begins to act before it is overtaken by the current given to the water by the action of the preceding part of the spiral, and, consequently, every part meets resistance from the water, and thereby gains a proportion of propelling power."

1827. Tredgold, in his work on Steam Navigation, notices several of the preceding plans, and enters into a full investigation of the properties of the screw as a marine propeller.

1828. Dec. 10; Charles Cummerow, of London, merchant, patented "certain improvements in propelling vessels," which he stated were "communicated by a foreigner residing abroad." These improvements consisted in the application of a screw at the stern, *placed in the dead-wood immediately before the keel.*

1829, Nov. 20. American Letters Patent were granted to Benjamin M. Smith, for the application of "sculling wheels, or screw propelling wheels to boats."

1831, April 27. American Letters Patent were granted to Doctor Giraud, for "a screw, or spiral lever, for the propelling of vessels."

1836, May 31. Mr. F. Petit Smith patented "an *improved* propeller," consisting of "a sort of screw, or worm." According to the description given in the specification, and the accompanying drawings of this "sort of screw," it differed in nothing from any other sort of screw; and so far, therefore, as the "propeller" was concerned, no *improvement was shown.* The drawing, however, represents the screw as being placed in a recess cut in the dead-wood immediately before the rudder; and on this peculiarity of position, though both Cummerow and Woodcroft had before proposed the same thing, has been founded a claim to novelty! At first, indeed, the patentee laid no stress whatever on this circumstance, for his original claim was in these words: "I claim, as my invention, the propeller herein-before described, *whether arranged singly in an open space in the dead-wood, or* (in duplicate) *one on each side of the same, or more forward, or more aft, higher up, or lower down, completely, or partially, immersed;*" but afterwards (May 28, 1839,) he entered a Memorandum of Alteration, in which he represented the placing of the propeller in the dead-wood, as being the principal feature of his invention. "*Since* the enrolment of my specification," he says, "I find that the dead-wood, or run of the vessel, *is the only place* in which the said propeller can be advantageously placed, and that a screw of one turn, or two half turns, as a propeller, will be sufficient for every purpose." And "for this reason," and in order to *limit* his claim accordingly, he substitutes for the words which have been just quoted, the following: "I claim as my invention the propeller described in figs. 1, 2, 3, of the drawing annexed to *this memorandum of alteration*, and placed singly *in the centre of the dead-wood*, or run of the vessel, as shown in the figures of the drawing annexed to the original specification." As represented in the drawing annexed to the original specification, the screw is of a single thread; but in the drawings which accompany the Memorandum of Alteration, it is shown as be-

ing either of a single thread, or of a double thread, or a thread of two half turns. Now certainly to alter the specification in the way done by this memorandum, is not to *limit*, but greatly to *extend*, the patentee's original right against the provision of the statute in that respect. For by the original specification no novelty whatever was claimed either as regards the form of the propeller, or the place in which it was to be fixed; while, by the Memorandum of Alteration, he claims to appropriate to himself exclusively, not only the use of the screw with the two half turns, but also the placing of it in the dead-wood.

Mr. Smith's screw has since popularly obtained the name of the *Archimedes' screw;* but the actual screw of Archimedes, as described by Vitruvius, consisted of a spiral fixed within a cylinder, or case, so as to revolve along with it, while the screw of Mr. Smith has no case, and is wholly open to the water. The American invention, mentioned by Marestier, and that of Scott, of Ormiston, were more like the screw of Archimedes, only that the screw in these cases revolved by itself, while the cylinder enclosing them remained stationary.

1836, July. Captain Ericsson patented a propeller consisting of six blades, each of the form of a segment of a screw, attached at equal distances to a cylinder, three of which blades are extended inwards as far as the axis, so that the greater portion of the impinging surface is exterior to the cylinder at a distance from the axis.

1838. Captain George Smith took out a patent for applying two propellers, consisting of plain blades, one on each side of the dead-wood.

1839, Nov. 25. Mr. John Hunt took out a patent for combining a stern propeller and rudder in one; the blades of the propeller were to be of *any* suitable form.

1839, Nov. 26. Mr. George Rennie patented his conoidal propellor, which differs from all others before proposed in this, that the lines of the screw are obtained from the circumvolution of a thread round a cone instead of a cylinder, whereby the diameter of the screw, rearward of the leading part, is progressively diminished, and in proportion thereto the amount of prejudicial resistance.

1839, Jan. 22. Mr. J. C. Haddan patented the "forming and using of screws with openings, or spaces, in the central portions of the threads," whereby "the velocity of the impinging, or propelling surface, is rendered more equal, and a passage afforded for the water through the centre."

1840, May 28. Mr. George Blaxland patented the use of "one or more inclined planes," (not segments of a *screw*, but plain blades,) to be fixed at right angles to a revolving, horizontal shaft, placed in the after part of the keel, forwards of the rudder-post, which inclined planes (are to) work in the water below the water line, in an opening formed in the dead-wood of the vessel," &c.

1830, June 13. Captain Carpenter patented the use of two propellers of a trapezoidal form, to be placed in the stern quarters of the vessel.

1843, Jan. 19. Mr. Thomas Sunderland patented a stern propeller, having blades attached, not immediately to the shaft, but to the ends of a cross-bar affixed to it, and of such a curved form that every point of the outer edge is equi-distant from a straight line drawn through the centre of the shaft.

A writer in a succeeding number adds the following:—

Captain Ericsson's propeller, as patented in this country July 13, 1836, consists of two wheels of wrought iron, formed by a series of spiral plates rivetted to narrow cylinders of the same material, which are connected by radiating spiral arms to the centre. These wheels are attached to shafts, (the one to which the inner wheel is fixed being hollow,) passing through the stern of the vessel, and revolving in opposite directions, each series of plates being so placed on the cylinders." So far from the Appendix to Byrne's observations "on the best means of propelling ships." Upon referring to the specification of this patent, I am able to add, that the number of blades is upon each cylinder eight—that the cylinder is supported by three spiral arms—that a narrow cylinder surrounds the spiral blades—that the two *(which are claimed as one propeller)* revolve at different speeds by means of cogged-wheels, and that they are placed abaft the rudder, (which is cut in two) and supported by a bearing from the false stern, which takes the shaft between the two wheels. The claims are to the whole arrangement of the propeller, as described.

Woodcroft's patent is, I think, dated March 22, 1832, and not November 18, 1826.

Blaxland's patent should follow Carpenter's, being dated November 28th.

In your quotation from Mr. Blaxland's specification, you have omitted the words "propellers," after "inclined planes"—a choice of names being offered by Mr. Blaxland for his blades; and you have added in their place, "not segments of a screw, but plain blades." Upon reading the specification through—the only way, permit me to remark, such a document can be correctly understood—you will see that "in order to determine the angles at which the inclined plane, or planes, is, or are, to be fixed," &c. Mr. B. supplies a diagram, pointing out with singular precision, and in a manner worthy of notice, his mode of ascertaining these angles, which produce a blade whose inner circumference passes over the same distance as its outer does; and this could not possibly be the case were the blades flat. Again, Mr. B. says, "I rivet the inclined planes, which I prefer divided into three or more parts," &c. And here you must understand he is speaking of divided "inclined planes, or propellers;" and then, having fully described the nature of his blade, he secures to himself the right of applying it in an undivided, as well as in a divided state; for with reference to fig. 1, of the specification drawing, he says "the propeller is here shown with an undivided inclined plane," and in fig. 8, shows "an end view of the propeller used in fig. 1." Mr. Blaxland's "inclined plane, or propeller" may, therefore, be described as a short radiating blade, with its angle increasing from its

periphery to its inner circumference, according to the rule laid down, whether the blade be divided into strips, or not, set upon an arm, and at a distance from its boss; and to those who would know full particulars of its powers, it should be mentioned that it has beaten one propeller in France; two in one, and one in another of Her Majesty's steamers—two in the *Jane*, and twelve in Mr. Beale's steam pinnace.

Lond. Mech. Mag.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Kyanized Railroad Sleepers.

James Herron, Civ. Eng., has deposited at the Hall of the Franklin Institute, a section of a *kyanized chesnut sleeper* from the Baltimore and Susquehanna Railroad, which was prepared in July, 1838, laid in August of the same year, and taken up for the purpose of examination in August, 1843, having been in actual service for five years, as is attested by Robert S. Hollins, secretary for the company.

This interesting section, which may be seen at the Hall, is in a perfect state of preservation; and it is stated by the officers of the company, that all the *kyanized* sills are, without a single exception, as sound as the specimen referred to, whilst the unprepared sleepers of the same lot of timber have all decayed.

The great benefit which seems to have been experienced in the case before us, from *kyanizing* chesnut sleepers, is strictly conformable to experience upon several English railways; but this is the most striking example of the advantage of mercurial antiseptics that has fallen under our notice in the history of American railways, and on that account we call attention to it.

Com. Pub.

Burnett's Patent for Preserving Wood, &c.

The plan patented by Sir William Burnett, for the preservation o timber, canvas, cordage, &c., from dry-rot, mildew, moth, and the destructive effects of damp, or the combined action of air and water, is a colorless, metallic salt, (chloride of zinc) prepared for use by solution in water, in the proportion of 1 pound of the substance to 10 gallons of water; which quantity, procurable for the sum of 1*s.* 6*d.*, is sufficient to prepare and preserve half a load of timber. By a hydraulic injecting apparatus, employed in Her Majesty's Dockyard, at Portsmouth, which is capable of saturating twenty loads of timber at a time, the gravity of the wood is increased 64 per cent., although, afterwards, lessened by drying; by a stronger solution than the above, wood, canvas, cordage, &c., are rendered incombustible, and all the men-of-war are, in future, to have their magazines fitted with wood and felt, especially prepared for this purpose; and the solution being colorless, does not affect the color of the materials to which it is applied.

Numerous experiments have been tried, extending over a period

of nine years, to ascertain, with certainty, the effect of the process on various substances. Specimens of English oak, English elm, and Dantzic fir, one of each prepared with the solution, and one of each unprepared, were placed in the fungus pit at Woolwich, on the 25th of August, 1836, and taken out on the 15th of July, 1841, when the prepared specimens were found to be perfectly sound, while the unprepared English oak had a spot of fungus on one end, the English elm decayed, and the Dantzic fir had fungus outside, and was decayed at heart. A quantity of Burnetized deals, with other pieces of the same wood unprepared, were put down in the damp cellar of a house in Chatham Dockyard, where the floors had been repeatedly destroyed by dry-rot, and where large fungi were growing in 1838, and in 1842 all the unprepared wood had become completely rotten, while the Burnetized portion was completely sound, and relaid with more unprepared deals for further experiment. Six pieces of canvas, and three of woolen cloth prepared, and the like samples unprepared, were placed in a hole four feet deep, in a damp situation, and exposed to the sun, where they remained six months; they were then taken up, washed in plain water, and dried, then placed in a deal box, and deposited in a damp sink, but not in contact with water; they were left in this situation nine weeks, and when examined, the prepared articles were perfect as ever, the unprepared perfectly rotten. These are a few of the experiments, and which are sufficient to show the nature of the process, and the powerful effects of the solution, which is now universally adopted in Her Majesty's dockyards, and is coming into very general use.

In confirmation of the reported good qualities of Sir William Burnett's process, we have had the following letter handed to us:—

Tullamore, King's county, Ireland, July 10.

I certify that I have made use of a large quantity of *domestic timber* (beech, elm, and Scotch fir,) in the repairs of my boats on the Grand Canal, which was prepared in Sir William Burnett's process three years since; most of it I find to be perfectly sound, which would not have been the case had it not been so prepared, as I have had repeatedly *Memel timber* decayed in less time in the same situation.

(Signed) Thomas Barry.

Mining Journal.

Working of English Railways.

We copy from the "Civil Engineer and Architect's Journal," for September, 1843, a tabular statement, giving the particulars of the working of *twenty* English railways, for the first half of the year, 1843; this table will be found to contain statistics of a character useful to persons interested in such works, and we could wish that a similar degree of attention was more generally paid by the American railroad corporations, to their own statistics, for the reception of which, in a condensed form, our columns will be always open.

Com. Pub.

Tabular Statement for the half year, December 31, 1842, *to June* 30, 1843.

RAILWAYS.		....	....	RECEIPTS.			PAYMENTS.							....
Names.	Length in miles.	Total Expenditure.	Number of Passengers.	Passengers.	Goods.	Total.	Locomotive Power.	Carriages.	Maintenan'e of way, and Repairs.	Office Department.	Taxes and Rates.	Total Charges.	Interest.	Profit.
		£		£	£	£	£	£	£	£	£	£	£	£
Greenwich,*	3¾	1,030,108	705,204	21,344		26,587	3,500	3,490	1,044	1,551	3,304	13,957	11,550	1,080
Grand Junction,†	88¾	2,375,134		132,976	49,652	185,093	20,298	29,691	12,675	4,591	2,954	80,320		104,772
Manchester and Bolton,	10	777,956	139,408	11,571	6,293	17,811	1,095	3,110	732	754	268	5,959	5,282	9,008
North Union,	22	613,212		17,731	6,793	25,337	1,466	2,142	1,471	1,236	1,082	7,397	3,249	14,690
Chester and Birkenhead,	14½	509,810		11,491	1,298	13,307	2,110	2,382	1,089	237	172	5,990	2,525	2,837
Leeds and Selby,‡	20		99,782	3,756	8,158	11,914		1,251	567	444	477	2,739		9,175
Brighton,§	56	2,792,193		65,487	9,002	74,490	9,168	18,150	4,980	3,414	3,003	49,827	43,974	
North Midland,	72¾	3,424,766		56,551	46,263	102,814	10,267	13,922	9,012	1,400	2,659	36,760	21,200	44,854
Northern and Eastern Counties,‖	32¼	887,055		31,853	3,693	35,547	6,702	6,945	2,033		895	20,324	5,695	10,875
London and Birmingham,¶	112½	5,953,831		306,457	84,735	389,658	32,854	41,141	22,451	5,645	8,747	112,238	39,680	223,924
Midland Counties,	57	1,725,693		40,421	21,064	62,324	10,780	9,498	7,105	3,383	1,378	32,144	12,813	17,367
Great North of England,	74	1,230,604	64,177	19,754	13,225	32,979	2,830	3,497	3,700	1,844	1,184	12,355	14,202	7,00
Sheffield and Rotherham,**	5¼		185,234	7,040	953	8,116		2,107	486	371	420	3,384	1,199	3,578
Bolton and Preston,	14½	373,925		3,846	1,468	5,315	2,000	1,170	185		92	3,447		1,867
Great Western,††	118¼	6,651,928	725,127	254,603	75,400	330,003	33,403	54,640	23,985	4,118	8,592	159,232	86,836	82,886
Liverpool and Manchester,	51	1,578,601	225,728	60,752	48,217	108,960	10,182	27,698	4,440	2,193	3,608	48,121	3,777	57,062
Blackwall,	3¾	1,289,080		17,351	927	18,505			600		1,498	15,385	5,553	
Eastern Counties,	50¼	2,718,620	999,683			43,182	4,551	3,741	2,556	1,284	1,520	20,355	2,116	20,710
Birmingham and Gloucester,	55	1,470,730		35,514	7,104	42,618	7,968	6,956	6,444	1,290	382	56,046	13,633	4,266
York and North Midland,	27	673,056	165,627	26,369	13,388	45,163	5,846	5,145	1,177	462	974	43,603	3,958	27,600

* Greenwich Railway received for foot passengers £497, and toll £4,746. † Grand Junction paid Liverpool and Manchester Railway £8,016, and for rent £2,093. ‡ Leeds and Selby locomotive power is included in York and North Midland. § Brighton paid Croydon and Greenwich Railway for toll £11,109. ‖ Northern and Eastern paid Eastern Counties Railway for toll £3,749. It should be observed that the office expenses cannot be separated. ¶ London and Birmingham paid Aylesbury Railway for rent £1,250. In addition to the total outlay, there is the sum of £13,966 carried to the depreciation fund. ** Locomotive power not kept distinct. †† Great Western paid Bristol and Exeter, and Cheltenham Railway, for rent, £34,484. In addition to the outlay £5,000 is carried to the depreciation fund.

The Water-Pressure Engine at Freyburg, Saxony. By WILLIAM LEWIS BAKER, Grad. Ins. C. E.

The machine described in this communication was designed by Herrn Brendel in 1823, and constructed in 1824, for draining the "Alte Mördgrube" mine, one of the largest silver mines in the neighborhood of Freyburg, in Saxony. This engine, which is fixed at a depth of 360 feet below the surface of the ground, has two single-acting cast iron cylinders, each 18 inches in diameter, and 9 feet stroke, to the pistons of which are fixed strong timber piston rods, each attached at its upper end by a flat iron rod and chain, to the opposite segments of a horizontal working beam, thus connecting the pistons of the two cylinders, so that, when one is being moved upwards by the pressure of water underneath it, the other is depressed by the weight of all the pump-rods, and other moving parts to which it is connected. The admission and eduction of water from the cylinders is regulated by side valves worked by levers and tappets. The piston-rods give motion to the horizontal arms of two bell-crank levers, the diagonal arms of which move the main pump-rods, working 44 pumps in two sets of 22 each, placed one above another, at an angle of 45° with the horizon, each dipping into the delivery cistern of the pump immediately below it; this is repeated downwards for the whole series; and thus the water is raised from the bottom of the mine to the point where it runs off by an adit. Each pump has a lift of 30 feet 4 inches. The duty performed by this engine is stated by Gerstner,* to be as 70 to 100.

The author then gives a very minute account of the construction of the engine, illustrating the paper by three drawings, giving the general arrangement, and the detailed dimensions of all the working parts.

Remarks.—Mr. Taylor remarked that the water-pressure engine was of Hungarian origin; it was extensively used in Germany, and had lately been much improved in construction, particularly by abandoning the rude mode of placing a series of pumps over each other, as had been described in the paper. He believed that Smeaton erected the first engine of the kind in this country. Trevithick built one about 40 years since, with cylinders of 30 inches diameter. Another was erected by Mr. Fairbairn, and since then one had been built under the direction of Mr. Darlington, with cylinders of 50 inches diameter, and 10 ft. stroke, worked by a force of water of 22 fathoms, through a descending column of 30 inches diameter; the pumps worked by the engine were 42 inches in diameter, raising water from a depth of 22 fathoms; the usual speed of working was 4 strokes per minute, but he had seen it attain six strokes. The concussion produced by the closing of the valve at the end of the stroke, was generally very prejudicial to these engines; but in that made by Mr. Darlington, it was diminished by allowing the large valve to close a short time before the stroke finished, and bringing the piston home with a small valve; by this means no noise was heard beyond that of the rush of the water, and the violent shocks were avoided.

Civ. Eng. & Arch. Journ.

* Gerstner, "Handbuck der Mechanick," published at Vienna in 1834.

Franklin Institute.

Report of the launches of the steam-frigates Raritan and Princeton.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred the subject of determining the amount of friction on the ways for launching the steam-frigates Raritan and Princeton, REPORT :—

That some of their number visited the Navy Yard on the day before the launch of the first class frigate Raritan, for the purpose of consulting with Mr. Lenthall, the United States Naval Constructor, under whose direction the launch was to take place, as to the arrangements to be made for the contemplated observations, Mr. Lenthall entered fully into their views, and promptly tendered every accommodation and assistance that might be found necessary.

The preparations for launching were at that time nearly completed. The launching ways, formed of heavy timber sills, were laid on a foundation of masonry, with a descent of 7.676 feet, in a distance of 120 feet, measured along the plane, or 1 in 15.633, or 30° 40′ slope. They extended from the stem of the ship into the river, to a depth sufficient to allow her to plunge off without striking the bottom. The upper faces of the ways were carefully planed, and lubricated with a thick coating of tallow. On these were laid the bilge-ways, constituting the base of the movable cradle, in which the ship was to rest when launching. Above the bilge-ways was placed a timber blocking, fitted to the mould of the ship, and firmly secured by lashings passed under the keel. The wedges for raising the ship off the keel-blocks and shores, which yet supported her, were inserted between the bilge-ways and the blocking. Arrangements were made by the committee for observations by different methods, and at several points, which will now be described.

A series of vertical lines was marked on the bilge-ways on each side of the ship, at intervals increasing from six inches to six feet. Sights were placed for the guidance of the observer, who was to note the passage of each successive mark: the time, by a chronometer, being noted in tenths of a second, by a second observer; while a third recorded the coincidences of these double notings, on a time table prepared for the purpose. A similar series of marks at larger intervals, the greatest being ten feet, was made on the bilge of the ship; the transit of which was to be noted by an observer, who should mark the time by a chronograph on the seconds dial of a watch. A member of the committee agreed to prepare an apparatus for marking half seconds on a tape to be drawn from a reel by the ship, as she was launched.

On the day appointed, the committee met at the scene of action, and was subdivided into several parties, each charged with one of the posts of observation above described; in addition to which, a party on board the frigate undertook to note the time of passing the vertical timbers of the ship-house; the intervals between which were meas-

ured. The number and variety of independent observations would, it was supposed, afford a reasonable certainty of determining correctly the speed of the vessel at every point of her short career down the ways. This expectation was not realized; the speed from the moment of starting, was greater than had been anticipated, and consequently, the intervals marked for observation were too small to be accurately noted. The apparatus for marking the tape was prepared at such short notice, that no time was allowed for previous trial: the marking pencil was not properly secured to the pendulum, and was displaced soon after starting. This experiment consequently failed. The passage of the last mark of the series on the bilge-ways, was satisfactorily noted on both sides of the ship; and from these observations, together with those made by the party on board, it appears that she traversed 59 feet in 11 seconds. These numbers will be used to determine the coefficient of friction, and may be supposed to furnish a result approximately correct.

The experience acquired on this occasion, confirmed the opinion, that a properly adjusted mechanical arrangement would accomplish the desired object with greater certainty and accuracy, than any personal observations. The committee, therefore, requested two of their members, Messrs. Lukens and Saxton, each to prepare an apparatus for marking time upon a tape, to be in readiness for the launch of the United States steamer Princeton; which was to take place in a few weeks. These were accordingly prepared, and on trials made before the launch, both were found to operate satisfactorily. These two instruments operate on the same general principle, of marking the oscillations of a half second pendulum upon a tape, the end of which is attached to the body whose velocity is to be noted. The marking is effected in Mr. Saxton's apparatus, by a cam on the pendulum rod, which presses down a lever carrying a brass cup charged with vermillion paint. The bottom of the cup is pierced with a small hole, through which a minute quantity of the paint is deposited on the tape whenever the cup touches it. The lever and cup are thrown up by a counter-spring as soon as the cam has passed. In the other apparatus, made by Mr. Lukens, the marking machinery is more complicated; in order to make the stroke and recoil of the marking pen sudden, so as to produce a well defined mark without a trail. The pen is formed of a metal tube closed at the lower end, and pierced with several small holes in the bottom, and around the circumference near the bottom. This cylinder passes through, and nicely fits, an opening in the bottom of a cup which contains the marking ink. When the pen is at rest, its lower end is just within, and fills the opening in the bottom of the ink cup: the ink enters it through the small holes in the circumference, and thence oozing through those in the bottom, keeps that end supplied with marking material. A detached escapement wheel, impelled by a weight; when released from its detent by the pendulum, strikes the pen suddenly down upon the tape, and marks the passing point; a counter-spring instantly throws it up, and supports it in the intervals between the strokes. In both

machines the pendulum is started by a trigger let off by the moving body.

The preparations for the launch of the Princeton, were similar to those made for the Raritan: the grade of the ways was somewhat steeper, being about 1 in 13, and the pressure on a unit of bearing surface was considerably smaller. The estimated weight of the Raritan, when launched, was 1200 tons; the bearing area of the bilge-ways was 755 square feet; the pressure, therefore, was 3,560 lbs. to the foot. The weight of the Princeton, with the machinery on board, at that time was 577 tons; the bearing surface 566 square feet, giving a pressure of 2,280 lbs. to the foot.

The unusual want of buoyancy of the stern of this ship, consequent upon the insertion of the Ericsson propeller, in the place of her dead wood, it was feared might cause her to dip too much on entering the water; to prevent which several empty casks were lashed to the run, a few feet above the keel. As they were placed so high as not to enter the water during the time included in the observations used by the committee, they could have no effect on their results, and, consequently, no further notice of them is necessary.

The position of the vessel was so near the margin of the river, that the extremity of the keel was immersed at the start; and by the close of the time just spoken of, about 20 feet in length was immersed to the average depth of about 2 feet.

The marking instruments were placed one at each side of the vessel—Mr. Lukens' on the north, with 100 feet of tape, and Mr. Saxton's on the south, with 50 feet. The tapes were attached to the bilge-ways, together with a line for detaching them when nearly run out. Mr. Lukens' tape was accidentally displaced at the moment of starting, so that the pen struck at the side of it for some seconds; it was then drawn into its proper line, and was marked from that point to the end. Mr. Saxton's apparatus was more successful, the tape being distinctly marked from the start, and bearing a permanent record of the motion of the vessel. The result of this gratifying experiment is exhibited in the annexed table marked A. Table B shows the results from Mr. Lukens' tape, which, connected with the other, exhibits the ship's motion through nearly 100 feet.

By examining the table A, it will be perceived that the velocity during the first three-fourths of a second, was regularly accelerated, but very slow. In the next half second, an increased rate of acceleration was attained, which is regularly maintained during four seconds. After the lapse of $5\frac{1}{4}$ seconds, several irregularities occurred, indicating the operation of some retarding cause, the source of which is not ascertained. The only known changes of condition at this time, are, first, the increased immersion of the keel, causing a displacement of not more than two tons of water; and secondly, some possible difference in the lubricating effect of the tallow where it is under the water. The changes in these particulars would seem to be insufficient to produce the remarkable effects observed.

As the data thus obtained, indicate distinct periods in which the ratio of friction has different values; it is thought proper to determine

the coefficients separately for the first three-fourths of a second, and for the interval of 4 seconds, in which there is a regular acceleration; and lastly, for the whole period of 5¾ seconds, in order to connect the observations on the Princeton with the single result obtained from the Raritan.

For the determination of the coefficient of friction, the following formula has been used:—*

Let the weight of the ship be W,

Descent of ways in unit of length $\frac{h}{l}$,

Pressure on ways $W' = W, \frac{\sqrt{l^2 h^2}}{l}$,

Theoretical force down the ways $g' = \frac{g.h}{l}$,

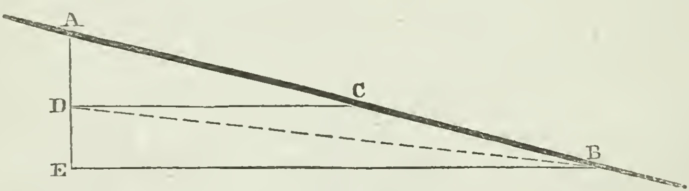
Observed force $g'' = \frac{2s}{t^2}$,

Resistance of friction $R = W. \frac{g' - g''}{g}$,

The coefficient of friction will be $\frac{R}{W'}, = \frac{g' - g''}{g} \div \frac{\sqrt{l^2 - h^2}}{l}$,

Equal to the retardation experienced, divided by the velocity acquired

* Another method of considering the subject of friction, upon inclined planes, has been suggested by a member of the committee, which results in a formula different from that we have employed.



Thus, calling A C = S, the space actually slid over in a given time, t, by any body descending an inclined plane.

A B = S′, the space which the body would have described by theory in the given time, $t = \frac{1}{2} g t^2$ sin. i, friction being null.

A B E = i, the angle of inclination which the plane forms with the horizon.

D B E = f, the angle of friction due to the body.

Then A E, being the total vertical space through which the body would have fallen in the given time, t, if friction had not existed; and A D, being the actual vertical space fallen through in the given time, t, it follows that D E represents the retardation due to the friction of the body upon the plane A B. D B E will be the angle of friction of the body, and $\frac{DE}{BE}$ will be the tangent of the the angle, f, or coefficient of the friction of motion pertaining to that body.

Knowing then simply the actual time occupied by the sliding body, in descending any measured distance along the plane, the formula, for finding the coefficient of its friction, will be

$$\text{Tang. } f = \text{Tang. } i \left(\frac{S' - S}{S'} \right)$$

By this formula the angle of friction of the Raritan frigate, computed from a time of 11

in the observed time by a body falling freely, multiplied by the ratio of the length to the base, of the plane.

If we apply this formula to the observation on the Raritan, we shall have $h=1$, $l=15.633$, $\sqrt{l^2-h^2}=15.277$, $g'=\frac{32.2}{15.633}=2.0597$ ft. per second, $g''=\frac{118}{112}=.975$ feet per second.

$$\text{Therefore, } \frac{R}{W'}=\frac{1.0846}{32.2}\times\frac{15.633}{15.277}=\frac{1}{29.01}.$$

In the case of the Princeton we have

$$h=1,\ l=13,\ \sqrt{l^2-h^2}=12.966,\ g'=\frac{32.2}{13}=2.477.$$

For the first $\frac{3}{4}$ seconds,

$$g''=.37, \text{ and } \frac{R}{W'}=\frac{2.107}{32.2}\times\frac{13.}{12.966}=\frac{27.39}{417.5}=\frac{1}{15.24}.$$

For the next 4 seconds,

$$g''=1.74, \text{ and } \frac{R}{W'}=\frac{.733}{32.2}\times\frac{13.}{12.966}=\frac{9.529}{417.5}=\frac{1}{44.97}.$$

For the whole $5\frac{1}{4}$ secs. $g''=1.42\ \frac{R}{W'}=\frac{13.689}{417.5}=\frac{1}{30.5.}$.

This last result represents very nearly the average for the whole length of Mr. Saxton's tape; the distance being 48.8, and the time $8\frac{1}{4}$ seconds.

The value of g'' is, therefore, 1.43, and $\frac{R}{W'}=\frac{1}{30.67}$.

If we extend our calculation still further, and take the last measurement given by Mr. Luken's tape, we shall find the mean resistance to the ship's motion to continue nearly uniform to that period, notwithstanding the immersion of nearly 100 feet of her length, to an average depth of almost 4 feet.

The value of g'', for this period of $11\frac{1}{4}$ seconds, is 1.509, and $\frac{R}{W'}=\frac{1}{32.89}$, being somewhat less than the earlier average, because it is less effected by the very high coefficients given in the first $\frac{3}{4}$ of a second, which involved the friction of rest.

Morin's experiments upon the sliding of plane surfaces of wood upon wood, with coatings of tallow, give an average coefficient of

seconds, occupied in sliding 59 feet, upon a slip of 3° 40′ slope, is 1° 55′, the coefficient of friction, or natural tangent, of that angle being .0336, or nearly 1-30th.

The angle of friction of the Princeton steamer, computed by the same formula, from a time of $5\frac{1}{4}$ seconds, occupied in sliding 19.62 feet, upon a slip of 4° 25′ slope, is 1° 53′, the coefficient of friction, or natural tangent, of that angle being .0328, or rather more than 1-30th.

The mean of these two results, gives an angle of friction, for launching such vessels as these, of 1° 54′, or a coefficient of friction of very nearly 1-30th.

friction of $\frac{1}{13.7}$, and when the surfaces moved from rest of $\frac{1}{6.2}$.*

The greatest value of the coefficient of friction found by the committee, is $\frac{1}{15.2}$; the average of the two experiments, upon the Raritan and Princeton is $\frac{1}{29.8}$. All the errors, if any exist, in the experiments of the committee, would tend to make the coefficient appear greater than it really is, and yet it is less than one-half the average determined by the experiments of Morin.

The thickness of the coating of grease, in these cases, was more than one-fourth of an inch; and the great pressure must have rendered it liquid as the vessel passed over it—the heat generated being so great as to produce much smoking of the tallow, near the end of the launch.

TABLE A.

Measurement by Mr. Saxton's Tape.		
Time in seconds.	Distance in feet and inches.	Interval in feet and inches.
¼	¼	¼
¾	2½	2¼
1¼	9¼	6¾
1¾	1 8¼	11
2¼	3 0¾	1 4½
2¾	4 8¾	1 8
3¼	6 11	2 2¼
3¾	9 5⅛	2 6⅛
4¼	12 5¼	3 0⅛
4¾	15 9⅛	3 3⅝
5¼	19 7⅜	3 10¼
5¾	23 5¾	3 10⅜
6¼	28 1⅛	4 7⅜
6¾	32 6⅝	4 5½
7¼	37 8	5 1⅜
7¾	42 6½	4 10½
8¼	48 8	6 1½

TABLE B.

Measurement on Mr. Lukens' Tape. The first mark on this tape is at the distance of 16 feet 9 inches from zero. The corresponding time is taken from the other tape.			
Time in seconds.		Distance in feet and inches.	Interval in feet and inches.
5		16 9	4 2
5½		20 11	4 3¼
6		25 2¼	4 4½
6½		29 6¾	6 4¾
7		35 11½	5 6½
7½		41 6	
8	Supposed.	no mark.	12
8½		53 6	
9		61 5½	7 11½
9½		68 0½	6 7
10		75 5½	7 5
10½		83 2½	7 9
11		91 5½	8 3
11½		99 8½	8 3

By order of the Committee,

William Hamilton, Actuary.

Philadelphia, January 11th, 1844.

On Thomas Shriver's Bow-Spring for Carriages.

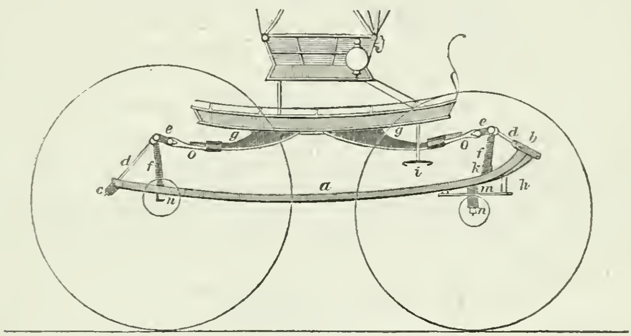
The Committee on Science and the Arts, constituted by the Franklin Institute, of the State of Pennsylvania for the Promotion of the Mechanic Arts, to whom was referred for examination the Bow-Spring for Carriages, invented by Thomas Shriver, of Cumberland, Maryland, Report:—

That they have examined two carriages constructed upon Mr. Shriver's plan, which may be described as follows, having reference

* In a note appended to his table of friction, given in the "Aide Memoire," page 309, Morin remarks, that when the unguent is continually renewed, and uniformly distributed, this ratio can be reduced to 1-20th. In a table published in the same work, on page 307, he states *the friction of rest*, between woods having unguents of tallow, at 1-10th.

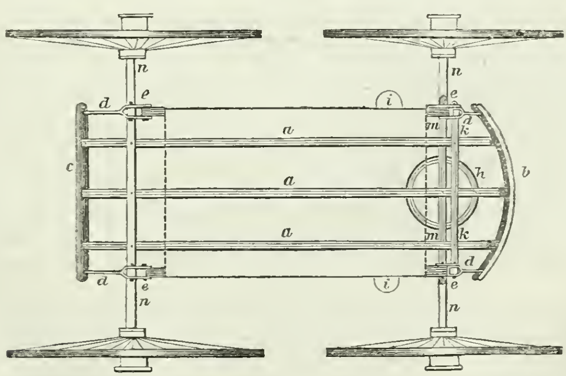
to a drawing hereto attached. The running gears, or frame, which supports the carriage body, mainly consists of three longitudinal pieces, or bows, of wood, *a, a, a,* framed to the bolster, *n,* which is attached to the hindermost axletree, and to two transom pieces, or bolsters, *m* and *k,* fixed over the front axletree—the piece, *m,* being under the pieces *a,* and resting on the pivot of the front axle—and the piece *k,* being on the pieces *a,* and extending upon each side about six inches beyond them. Upon the ends of the transom-piece *k,* and upon the bolster of the hindmost axle, posts, *f,* are framed, which are

Fig. 1.



a, a, a, Longitudinal Bow-Springs.
b, b, Front cross bow-spring.
c, c, Back do. do.
d, d, Iron stays.
e,e,e,e, Iron links connct'g leather brace.
f, f, Wooden suspension posts.
g, g, Body springs.
h, h, Iron pivot ring.
i, i, Steps.
k, k, Spring bolster.
m, m, Pivot bolster.
n, n, Axle, wooden part.
p, p, Axle, iron part.
o, o, Leather susp'g braces.

Fig. 2.



connected to the ends of the two cross pieces, *c* and *b,* by iron rods, *d*: the cross pieces, *c* and *b,* being framed and secured to the ends of the bow pieces, *a,* at a suitable bevel, to resist the tension strain of the rods, *d.* The upper ends of the posts, *f,* the rods, *d,* and the links, *e.*

are connected by bolts to the leather straps, *o*, and springs, *g*, which are attached to, and support, the carriage body. In light carriages, the front piece, *b*, is curved, as represented in the drawing, but in heavy vehicles, or stage coaches, it is usually made straight. The whole carriage frame operates as a spring, when pressed by the weight and action of the carriage body. The points, *e, e*, are drawn towards the centre, and cause the posts, *f*, to act upon each of the axles as a fulcrum, bending the bows, *a*, downwards in the centre, and upwards at the ends, by the tension of the rods, *d*.

The committee, after a minute examination of the subject, feel justified in expressing a very favorable opinion of these springs, combining, as they certainly do in a high degree, the essential qualities of lightness, simplicity, cheapness, and durability. This opinion is sustained by the written testimony of some who have extensively used them, and by the experience of several members of the committee, who have ridden in, and examined, both heavy stage coaches, and light carriages, equipped with bow-springs, all of which are successful, and received their decided approbation.

In the drawing attached, fig. 1, is a side elevation of the body of a light carriage constructed with these springs; and fig. 2, a horizontal projection, or plan.

By order of the Committee,

William Hamilton, Actuary.

Philadelphia, December 14th, 1843.

On Calderhead's Carpet Loom.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts, to whom was referred for examination the question of the novelty of the Loom devised by Alexander Calderhead, for weaving carpets, Report :—

That the main features of this invention, are placing the pattern cylinder under the warp, and causing it to act upon perpendicular needles, each of which has an eye through which a thread of the warp is passed, thus enabling each particular thread to be lifted by the pattern, at the proper moment, to produce a shed for the weft to pass through, and form a point in the figure of the fabric in hand.

The committee have not the slightest doubt, that Alexander Calderhead actually invented the improved loom before them, and think he deserves the highest credit for the ingenuity and perseverance with which, through many discouragements, he has labored to bring his loom to its present state of simplicity and perfection; and the committee will here incidentally observe, that they have good reason to believe that looms upon this simple plan will be found highly useful for weaving carpets, and similar fabrics of a coarse texture.

Nevertheless, an examination of previous patents has brought the committee to the conclusion, that the same form of loom, in all its essentials, has been before devised, and made the subject of a patent, by C. M. H. Molinard, which passed the Great Seal of England on

the 9th of April, 1833, (see Newton's London Journal of Arts, &c., vol. xv. conjoined series, page 287,) where the following description will be found:—

"The present invention is to place the roller which carries the pierced cards under the warp threads, in the back part of the loom, and to cause the pierced cards as they successively come into operation, to act against the under parts of a series of perpendicular needles, through the eyes of which the warp threads are severally passed."

This description precisely applies to the loom before us, which, therefore, *cannot be regarded as a new invention.*

By order of the Committee,

William Hamilton, Actuary.

Philadelphia, April 13*th*, 1843.

On Laubach's Blacksmith's Tuyere Iron.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts, to whom was referred for examination a Patent Tuyere Iron for smiths' forges, invented by Joseph Laubach, of Middletown, Dauphin county, Pennsylvania, Report:—

That they have examined the model of Laubach's Patent Tuyere Iron, with a revolving, or vibrating, hearth.

The improvement consists of a vertical cast-iron cylinder, about 8 or 10 inches in length, and from 4 to 5 inches in diameter, with a concave flanch at the upper end, that corresponds with and forms the bottom of the hearth; this flanch also projects inward, and contracts the opening in the cylinder to about 2 inches diameter; this aperture is regulated by a sort of triangular valve of cast-iron fixed on a rod that passes out in front of the forge, (similar to a throttle valve,) this valve regulates the quantity of blast, and closes the aperture when required, to prevent the small coal, or cinder, from falling into the cylinder, which is provided with a sliding bottom that may be withdrawn when necessary to discharge the coal, or cinder, that may have accumulated in the cylinder. There is a horizontal tube projecting from the side of the cylinder to receive the pipe of the bellows.

We believe the arrangement is new. The claim set forth by the inventor, is for constructing the blacksmith's forge with a revolving, or vibratory, hearth; and in combination therewith, the cylinder with a basined rim, forming part of the hearth, and having a tube to receive the nozzle of the bellows: said cylinder receiving the blast from the bellows, and serving as a receiver for the small cinder, as before described.

The committee are of opinion that it is superior to any of the former tuyeres that have been brought forward; they are, moreover, strengthened in their opinion by many certificates, which have been given of its superiority by persons who have made a trial of it, and would, therefore, recommend it to the notice of the public.

By order of the Committee,

William Hamilton, Actuary.

Philadelphia, October 12*th*, 1843.

English Patents.

Specification of a Patent granted to William Edward Newton, of Chancery Lane, *for improvements in manufacturing lime, cement, artificial stone, and such other compositions more particularly applicable to working under water, and in constructing buildings and other works, which are exposed to damp. Sealed the 3rd of April,* 1841.

This invention consists, firstly, in the formation, by certain new processes, of an hydraulic lime and cement, which has the property of becoming hard and solid, when under water, or exposed in damp situations; secondly, in the application of the same principles to the hardening of soft stones, for the purpose of making hard artificial stones; thirdly, in the employment of the same process for hardening wood, and preserving iron from the effects of damp, &c.

The following is the principle upon which the invention is founded, and the methods employed for carrying it into effect: The property which certain sorts of lime possess, of being hydraulic, or hardening under water, is caused by a certain combination of the lime with silica, alumina, and sometimes also with oxide of manganese, and oxide of iron. The object then of this invention, is to facilitate the combination of the lime with those oxides, by means of agents not hitherto employed. Thus, in operating by the dry method, as is generally the case, instead of calcining the lime-stone, or lime, with sand and clay, the inventor, in order to facilitate the combination of the silica and alumina with the lime, introduces a small quantity of potash, or soda, in the state of carbonate, sulphate, or chloride, or of any other salt of these bases, susceptible of decomposition, or becoming a silicate, when such calcination takes place. The salt of potash, or soda, the quantity of which varies from three to six per cent. to the quantity of lime, is employed in the state of solution, so as to penetrate and mix better with the alkaline salt in the chalk, or slacked lime. Calcination effects the rest, in the ordinary manner.

In order to combine, or incorporate, more equally by the dry method, the alumina, and the oxides of manganese, and of iron, with the lime, the sulphates of these bases are first decomposed by the slacked lime, by making a paste with a solution of the sulphates, mixed with the lime. This paste, into which the sulphates in question enter, in the proportion of from six to ten per cent, of the lime, is then calcined, in order to produce an hydraulic lime. All sorts of lime are made hydraulic, by the humid method, by mixing slacked lime with solutions of alum, or sulphates of alumina; but the best method consists in employing a solution of the silicates of potash, or of soda, called liquor of flints, or soluble glass. An hydraulic cement may also be made, which will serve for the manufacture of architectural ornaments, by making a paste of pulverized chalk, and a solution of the silicate of potash, or of soda: in working with this plaster, it becomes much harder than ordinary plaster.

These same silicates of potash, or soda, dissolved in water, will also harden chalk, or soft and porous stones, and transform them, artificially, into hard stones. In order to do this, these soft stones, either rough, or cut into their proper forms, must be soaked in a solution of the silicate, either warm or cold, and allowed to remain there a longer, or shorter time, according to the degree of hardness which it may be necessary to give them; after which, they must be taken out and left exposed to the air. At the end of a few days, stones, thus prepared, will have acquired a hardness equal to that of marble; and this quality, in a little time, pervades the whole mass; for if, for the purpose of polishing, the outer coat, or surface, be removed, the inner one, which at first is not so hard, will harden in its turn, by exposure to the air. This takes place as far as the silicate has been able to penetrate. A more superficial hardness is obtained, by applying the solution of the silicate of potash, or soda, by means of a brush. It is in this manner that walls, constructed of chalk and mortar, may be hardened. Sculpture, and various other objects, which may be made, or prepared, in chalk, may be hardened, and afterwards serve for decorating buildings, and other purposes, without the fear of their becoming injured by frost or damp. Chalk, hardened in this manner, may also be used as a substitute for the stones now employed by lithographers. Plaster models may also be hardened, by placing them, for some time, in a solution of the silicate; but it would be still better to add a portion of the solution to the paste, at the time of making the model, or using the plaster. The silicate of potash, or soda, is prepared by fusing one part of white siliceous matter with from one and a half to two parts of potash, or soda, in the ordinary reverberatory furnaces, or in a glass maker's, or iron, crucible. The solutions may be used of any density for plaster; but they should be weaker for chalk. In the last place, the inventor has found that the silicates of potash, or soda, when dissolved in water, decompose spontaneously in the air, and cover the objects, to which their solution has been applied, with a strong covering, or layer; therefore, by applying the solution of silicate of potash, or of soda, to polished iron, and allowing it to dry in the air, the metal is preserved from oxidation. By soaking wood many times in this solution, and allowing it to dry in the open air, every time after it has been placed therein, it becomes so much penetrated with silica, that it acquires a considerable density and degree of indestructibility.

The solution of the silicate of potash is not the only substance which, by being injected into porous bodies, tends to harden them. A mixture, made from a solution of bicarbonate of ammonia, and of chloride of magnesium, may be successfully employed; or a mixture of the solutions of ammonia and chloride of calcium, may be used. In these latter cases, instead of having siliceous injections, they are either magnesian or calcareous. Soft and porous stones may also be considerably hardened, and defended from the action of damp, by first well drying them, and then dipping, or steeping, them in sulphur, or some natural, or artificial resinous, or bituminous, substance, rendered liquid by heat.

The patentee claims, firstly, the application of certain new means, to change or convert all descriptions of lime into hydraulic limes and cements, or such as become hard under water, or when exposed in damp situations, by combining these limes and cements with silica, alumina, the oxide of manganese, or the oxide of iron, either by the dry, or humid method. Secondly, the manufacture of hard artificial stones from chalk, plaster, and all porous stones in general, by injecting into them, or imbuing them, with silica, or the carbonates of magnesia, or lime, by any of the above described processes; or by causing them, by virtue of their porous nature, to absorb either melted sulphur, or bituminous, resinous, or fatty matters, properly liquified by means of heat. Thirdly, in the employment of the silicates of potash, or soda, for making, or forming, a stony plaster, or coating, upon a variety of substances, thereby preventing iron from becoming rusty, or oxidized, and rendering wood and other organic matters harder, and not liable to decay.—[Enrolled in the Petty Bag Office, Sept. 1841.]

Lond. Journn. Arts & Scien.

Specification of a Patent granted to John George Shipley, *for certain improvements in Saddles; patent dated October* 6, 1842; *specification enrolled April* 6, 1843.

The first of these improvements consists in having the "pannel" quite detached from the "tree:" in saddles this has not heretofore been the case, which is the cause of frequent annoyance; as, for instance, when the pannel gets wet, the saddle cannot be put before a fire to dry, because the other materials of which it is composed are liable to be injured by the heat. Mr. Shipley attaches the "pannel" to the "tree" with springs, which, when pushed into their places, are not easily withdrawn, but yield to pressure, applied for the express purpose, when the pannel is required to be taken out to dry, repair, &c. To the under side of the "tree" there are thongs attached, by which movable pieces of thick felt lining may be attached thereto, and one piece readily changed for another, so that the same saddle which fits one animal may be made in a few minutes to answer for a larger. These thongs also serve to attach metal plates by, instead of the lining, on occasions when it is required to carry a definite weight, as in racing, or steeple chases. Mr. S. also forms the "tree" of bars of steel and whalebone, or either separately. The "straining" is formed of whalebone and canvas, being attached to the saddle in the usual manner.

The patentee claims, 1. The connecting the "pannel" to the "tree" with springs, or hooks.

2. The using of movable felt linings.

3. The attaching of metallic plates for additional weight.

4. The formation of the "tree" of bars of steel and whalebone, separate or combined.

Lond. Mechanics' Magazine.

Specification of a Patent granted to Peter Kagenbusch, *for certain improvements in the treatment of the Alum Rock, or Schist, and in the manufacture and application of the products derived therefrom. Patent dated* 13*th October,* 1842 ; *specification enrolled* 13*th of April,* 1843.

Mr. Kagenbusch makes four distinct claims:—The first is, for making "water heaps," or heaps of the alum shale broken small, and sprinkled with water as the heap is laid. The heaps are to be plastered over in the usual way, and are to stand from three to eight months.

The 2nd. For burning these "water heaps," at the expiration of this time in kilns, or close heaps with *turf;* wood or coal may be used.

The 3rd. For steeping the alum shale, when burned, in the pits along with kelp, or for steeping kelp in raw alum liquor, in the proportion of three quarters of a ton of kelp to as much alum shale, or alum liquor, as will yield one ton of alum.

And the 4th. For burning the exhausted shale on iron plates alone, to make puzzolana, or with lime, in kilns—made into bricks, or lumps, for hydraulic cement.

In order fully to appreciate these improvements, it is necessary to inform our readers, that the alum rock on the Yorkshire coast yields, besides alum, another salt in equal quantity, which is a mixed sulphate of magnesia and iron. This salt formerly was suffered to run into the sea, but of late years about one-half of it has been preserved for sale in all the works—the Boulby works alone recovering the whole of the sulphate of magnesia entirely free from iron. About one ton of pure sulphate of magnesia may be obtained for every ton of alum, by proper management.

It is well known that some of the alum rocks on the Continent, yield alum by spontaneous decomposition, which is the object intended to be effected by the first claim in the present patent; and it is equally well known that the Yorkshire alum schist will not, and the fact is noticed in a paper published in vol. xii, of the Phil. Trans. for 1676, page 1052, by D. Colwell, Esq., in which he says, "the rock exposed to the air and moisture, crumbles and produces green vitriol, but being burned, is fit for alum." And we have the authority of the late Mr. Sowerby, of Whitby, that such a mode of heap making was tried at the Mulgrave works without success.

The second claim is for the employment of turf as fuel.

The third claim is for the exclusive privilege of "advancing backwards" to the rudest mode of employing kelp, described in the paper above alluded to, as "practiced commonly in the alum works in Yorkshire, from Scarboro' to the river Tees," but long since laid aside.

Muriate, or sulphate of potash, or sulphate of ammonia, are now used by alum makers as the source of the alkali necessary to form alum—the potash salts being obtained from kelp.

One ton of absolutely pure muriate of potash (K Cl) will yield potash equivalent to 6¼ tons of alum; but it is found, in practice, that not more than from 4 to 5 tons of alum are produced from one ton of the muriate of potash of commerce. Now, one ton of kelp yields from 5 to 6 cwt. of such muriate. The patentee, then, we see, employs about the *practical* equivalent of kelp to produce a ton of alum, but he would appear to be altogether ignorant of the fact, that the carbonate of soda, and sulphuret of sodium included in the kelp, will, as far as they go, decompose his alum, and that the sulphate of soda will remain in his "mother liquors," to contaminate the sulphate of magnesia, by which means he will commit, we hope, an *involuntary* fraud upon the purchasers of this latter salt.

There is another mischief to the alum maker, in this rude mode of employing kelp, which may not be generally anticipated. An eminent chemist has informed us, that he has proved the presence of sulpho-cyanogen compounds in kelp, by their producing the characteristic blood red color with the iron in the alum liquor. This has already been productive of serious injury to the alum in the Mulgrave Works, from the employment of muriate of potash drenched with kelp "mother liquors."

The fourth improvement, "for burning the exhausted shale on iron plates alone," is not likely to be interfered with by cement makers, whose object is to make money at the same time.

It has been for a long time the opinion of the best chemical authorities that the "artificial alum makers," on the Tyne, will, in time, supersede the "natural alum makers," as they are incorrectly termed, seeing that the process followed by each is equally artificial; and these *improvements* do not tend, in the slightest degree, to shake that opinion. Ibid.

Mechanics, Physics, and Chemistry.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On the protection afforded to Iron by a coating of Zinc.

In the number of the "*Civil Engineer and Architect's Journal,*" for November, 1843, page 386, there is an abstract of the proceedings of the Institution of Civil Engineers, relating to the subject of the protection of iron, by what has been very improperly termed *galvanizing* it; the term zincing is certainly much more appropriate, as the process of covering the iron with zinc is perfectly analogous to that of tinning.

When the patent was obtained for this process, by Mr. Sorel, it was believed that a coating of zinc would effectually protect iron from oxidation, even in those parts which happened not to be covered, or from which the zinc might be accidentally abraded. The fallacy of this assertion was, however, at a very early day, practically demonstrated. Zinced sheet iron was used as a covering for roofs, in the city of New York, soon after the issuing of the patent, but the protec-

tion afforded appeared to be merely mechanical, like that of covering sheet iron with tin; wherever there were flaws in the iron, the water and air which came into contact with the uncovered part, appeared to act more rapidly than upon sheets of common iron. Specimens of iron, thus corroded after a brief exposure to the weather, were sent to the writer of this article for examination, in consequence of the interest he had taken in a process then deemed so promising, and which seemed to be justified by the known laws of galvanism.

It now appears manifest that the resulting failure has been produced by the impurities always existing in the zinc of commerce, and from which it cannot be readily freed. It also is now known that if the zinc could be obtained in a state of absolute purity, it would be rapidly deteriorated in the act of applying it to the iron in the ordinary way. In the article referred to, it is remarked, that "zinc, like most metals in commerce, is not to be met with pure; in the other metals, however, the impurities do not generally tend to the injury of the metals with which they are combined: such, however, is not the case with zinc and its impurities, as when in contact with moisture, they generate a galvanic action, by which the zinc is rapidly destroyed. Those who have made use of zinc, especially where it has been exposed to exciting fluids, such as milk, or other fluid, easily converted into acid, are well aware of the rapidity of its destruction." As the result of the facts thus stated, it is contended "that impure zinc being itself so destructible, is of little value, as it cannot afford protection to any other metal which may be coated with it; and, therefore, coating iron with melted zinc (of commerce) must be objectionable."

In a report, made by M. Dumas, to the French Academy, he says, "that zincing of iron by steeping it in a bath of melted zinc, has many inconveniences: besides, the iron combining with the zinc, constitutes a very brittle, superficial alloy, the iron losing its tenacity." In this process also the zinc, if pure at first, will itself become deteriorated, as it will rapidly, in its fused state, combine with a portion of the iron which it is intended to cover, and will become an alloy of that metal.

Mr. F. Pellatt, in the paper above referred to, proposes to coat iron with zinc by the electro process, which, he states, will cause the pure zinc only to be deposited on the iron, and the amalgamation which takes place when the melted metal is used, is altogether avoided. In proof of the goodness of the process, it is stated that "some thin plates which had been exposed for eight months on roofs in London, did not exhibit any appearance of rust." This process is represented as easily performed on any scale, but Mr. Pellatt "had not made accurate experiments as to the efficacy of the process, when applied to iron exposed to the action of sea-water; but he feared the result on account of the formation of muriate of zinc."

It is believed that there are but few chemists who will not participate in the fear last expressed, for, should it eventually appear that the zincing, when effected by the electro process, will stand the test of time on sheets used for roofing, or otherwise exposed to the action of fresh water only, which may be fairly doubted, it would not follow

that it would be permanent when exposed to saline mixtures, such as the muriates, and others, existing in sea-water.

The English have built a large number of iron vessels, but the writer is not aware that any attempt has been made there to protect them by the zincing process, and the foregoing remarks may serve to show why this has not been done. The process has failed in affording protection under circumstances less trying than that of an exposure to sea-water, and listening to the dictates of common prudence, they have avoided the venturing upon an experiment not sanctioned by the observations already made, and which could not be tried on so large a scale, but at a cost which it would be temerity to encounter in the face of anticipated failure.

Practical Remarks on Blast Furnaces. By GEORGE THOMSON, Esq., Mining Engineer.

There is a manifest absence of anything like correct principle in iron smelting; and, although the reduction of ore by cementation may be an easily explained operation, yet, the peculiar combinations brought to bear in the blast furnace, seem to present a problem which chemical science is as yet unable to explain.

In the attempted solutions of the problem, a too limited number of facts have been generally considered, and generalizations attempted, from facts bearing partially on unvaried conditions. Following the system of induction, if a true principle is only to be attained through the medium of facts in every variety, and under every possible condition, the object may be assisted, in some measure, by my laying before the Society a few facts which have come under my own observation, and may be peculiar. The results given are divided into three principal conditions, viz., 1st, as respects the direct influence, *cæteris paribus,* of different material. 2nd. Influence of shape and size. 3rd. Influence of blast, as to diffusion, pressure, or quantity.

1st. *Influence of Material.*—Although *all* the materials used in smelting have a certain influence; it is the coal which gives the most extraordinary results as respects "yield." A few results of various coals, are, therefore, collected into the following table from my own immediate observations. The word "yield," is used to denote the comparative quantity of coals used in the furnace, to produce, or to smelt, a ton of iron. In the table, the weekly quantity of iron given, as produced by hot blast, is small in comparison with what is now made at most furnaces; yet these are the more correct *comparative* results, having been attained with like conditions of size, shape, number of tuyeres, &c. Since that time, the shape and size of furnaces have been materially altered, as well as other conditions, and the make greatly increased.

Referring to the table, the first three coals are found in the same coal field, and at no very great depth from each other. The cold blast results of these came directly under my own observation, and

are taken from several years' work; the hot blast results are from a neighboring work, and subject to similar conditions in almost every respect. Here, then, in the same coal field, are three different coals, which, when under similar conditions with cold blast, give very different results; so much so as to have taken nearly twice as much of one kind of coal to make a ton of iron as of another (yard coal $5\frac{1}{2}$ tons, clod coal 3 tons,) but when the hot blast is applied, we find they are very nearly assimilated, so that, upon the coal which works *best* with cold blast, that application has scarcely any effect, while on the inferior coal it has a most surprising one.

TABLE No. 1.

PLACES.	COALS.			RESULTS.				
				COLD BLAST.		HOT BLAST.		
	No.	Local Names.	Loss in Coking.	Coal to a Ton of Iron in Furnace.	Weekly Produce from one Furnace.	"Raw," or Coked.	Coal to a Ton of Iron in Furnace.	Weekly Produce. from one Furnace.
Shropshire, (Lightmoor Works,)	1	Clod Coal,	45 per cent.	3 Tons.	70 Tons.	Coked.	$2\frac{1}{2}$ Tons.	80 Tons.
	2	Yard Coal,	50 "	5 to $5\frac{1}{2}$	40	Coked.	$3\frac{1}{2}$ to 3	80 "
	3	Little Flint Coal,	50 "	4	50 to 60	Coked.	$2\frac{1}{2}$ to 3	80 "
		Do.	Uncoked.	$2\frac{1}{2}$ to 3	50 to 60			"
South Staffordshire, (Wedensbury Work,)	4	Thick Coal,	45 per cent.	3	60	Raw.	$2\frac{1}{4}$	80 "
	5	Tipton Coal,	45 "	$5\frac{1}{2}$	35	Raw.	$2\frac{1}{2}$	60 "
North Staffordshire, (Fenton Park,)	6	Ash Coal,	50 "	$5\frac{1}{2}$	35	$\frac{1}{2}$ ck. $\frac{1}{2}$ rw.	$3\frac{1}{2}$	45 "
	7	Rider Coal,	55 "	$7\frac{1}{2}$	25	Coked.	$4\frac{1}{4}$	40 "

DESCRIPTION OF COALS.

No. 1 is soft, stratified, and dull; horizontal sections filled with carbonaceous matter; burns with a white ash; produces a soft coke, which retains carbonaceous matter in divisions.

No. 2, rather hard, cubical and bright; calcareous matter in transverse divisions; burns to a brown ash; produces a hard coke, and is considered very sulphury.

No. 3, hard, cubical, shining; burns to a white ash; produces a very hard coke.

No. 4, is of various stratifications, differing in character; is generally known.

No. 5, Schistous, very friable, with carbonaceous matter between horizontal layers.

No. 6, bright, conchoidal, free burning, and renders a white ash; is preferred for burning the china and "pottery ware" of the district.

No. 7, bright, conchoidal, burns very hot, leaves a brown ash. A stratum of pyrites lies directly below it in the coal field of about 6 inches thick.

The two next coals in the table from the Wolverhampton coal field, show a similar result. The sixth and seventh, or the last two coals

of table No. 1, belong to North Staffordshire—the district of the "Potteries." There my results are also given from a direct personal observation of several years; and I do not think I err in saying, that the materials of this district, taking coal and iron stone together, are the worst in the kingdom for iron smelting. The coals given are compared under precisely similar conditions, both with cold and hot blast, and, although obtained from the working of a very small furnace, (only 32 feet high,) the *comparative* results will not be affected thereby. They lie very close to each other, being merely separated by a stratum of shale a few feet in thickness, often less, and, consequently, show how great a difference occurs, not only in different districts, but within a few yards, vertically, of the same field.

With modifications of shape, and increase of size, (to which we shall attend more particularly under that head,) we were ultimately able to work No. 6, (ash coal) in the furnace without coking, and at a consumption of only 2½ tons to the ton of iron, with a make of upwards of 70 tons a week; but No. 7, (rider coal,) although these conditions altered the make considerably, and the yield slightly, we were never able to work *without* coking; again and again we tried to do so by commencing with a small quantity, and gradually increasing it, but in vain: every increase of this coal to the burden, without coking, was followed by a decrease of yield, make, and quality.

As regards iron stone, the effects of different qualities are not so striking as those of coal, with respect to *yield*, but they have a great influence on the *quality* of the iron produced. For instance, that which is known as the Shropshire penny stone—a peculiar kind of argillaceous iron stone found in small nodules imbedded in a stratum of indurated clay—and containing about 30 to 35 per cent. of iron, is supposed to give the peculiar strength and toughness to the Shropshire pig iron. When another iron stone, (siliceous) locally termed "crawstone," which is found partially stratified in a bed of sandstone rock, is mixed with the pennystone, even in proportion of 1 to 10, the effect is very observable in making the iron much more fluid, although it retains its stoutness. Again, the effect of the "red ore" of Cumberland, or peroxide of iron, mixed with argillaceous, or other iron stone, is well known; it adds in every case very materially to the strength of the iron, and the effect is especially so with the hot blast. Forge cinder, which is a protoxide of iron, mixed with siliceous, or other foreign matter, has a directly contrary effect, both with cold and hot blast,—so much so indeed, that I have seen hot blast iron which had been made with a large proportion of "cinder," so weak as to break into several pieces when dropped on the ground from the height of a couple of feet. I may here remark, that it is not surprising that we should hear so many conflicting opinions on the *strength* of hot blast pigs, by those who only quote results without considering the conditions which affect them.

These results on the quality of iron by the use of different kinds of iron stone, are very general, but such effects are well known, and are constant; and when we consider that there is only one kind of iron,

in fact, surely it is worthy the attention of the scientific to inquire whence arise such differences, and how they should be produced by a simple mixture of "red ore," or of "forge cinder."

2nd. *Influence of Shape and Size.*—We now come to a few results connected with the shape of furnaces; and on this point there seems to be at different times a ruling fashion. At the time of making the experiment to which I shall first refer, which was before the hot blast had been brought into notice, the prevailing fashion in England was to make the furnaces as narrow as possible, both at the "neck," (or filling place,) and at the "hearth." The furnace on which the experiment was made, was at Lightmoor, in Shropshire. the shape and size of which is represented in Fig. 1. It worked worse than any of the others with the same coal, which was a mixture of those already referred to in table 1; and the only difference of its shape, compared with the others, is in being about 6 to 9 inches wider at the boshes, and 3 feet less in height.

Fig. 1.

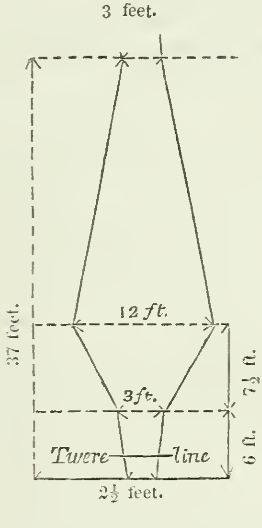
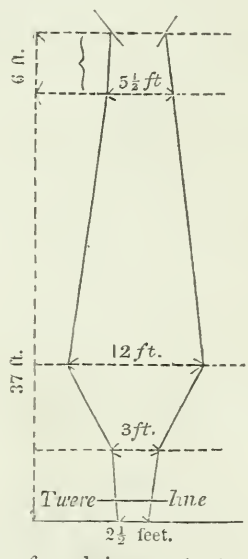


Fig. 2.



This furnace consumed about 5 tons of coal in producing a ton o iron, and made only about 40 tons per week. The alteration made upon it was very simple to appearance, consisting only of widening the top from 3 feet, to 5½ feet diameter, and carrying that width perpendicularly up 6 feet higher; also placing two filling holes, one on each side, over tuyeres, instead of one in the middle, merely, as it were, placing a cylinder of 5½ feet diameter, and 6 feet high upon the top, as represented in Fig. 2.

Simple as the alteration appears, however, it was followed by very extraordinary results; the moment the charge arrived at the bottom.

the iron, from hard forge, became fine No. 1. The burden was accordingly increased from time to time, until this furnace, with the same material, and same blast, made 60 *tons* per week of good forge pigs, with a consumption of only $3\frac{1}{2}$ *tons* of coal to a ton of iron. The result is not attributable to the widening and double filling holes *alone;* for the effect was repeatedly tried by filling holes at the *original height, directly under* the upper ones, and in every case we had to take burden off to make an equal quality, thereby reducing both the quantity and the yield.

Mr. Gibbons, of Corbyns Hall Furnaces, near Dudley, has arrived at very striking results with cold blast, by alteration of shape, and increase of size. He states in his publication on the subject, that he was led to the idea by observing the well known fact, that furnaces, especially cold blast ones, scarcely ever come into full work until six months after they have been blown in; and also, that every year, so long as the "boshing" of the furnace is not wholly gone, they improve their work, both in yield and in quantity: further, in observing that furnaces, when blown out, although they had not been working for more than six or eight months, were materially altered from their original shape. By studying the natural shape, as it might be termed, he has arrived at an improved form, as at fig. 4.

Fig. 3.

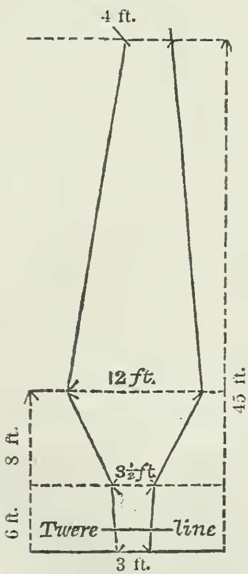
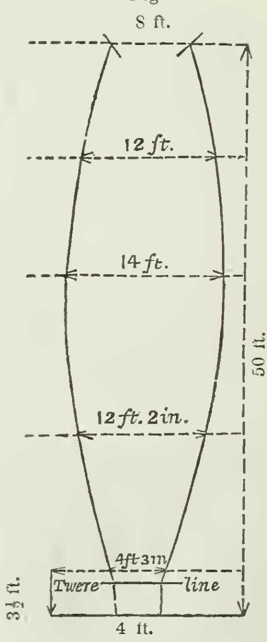


Fig. 4.



This improved furnace, fig. 4, has more than double the capacity of his original one, fig. 3, and the larger content is in the *upper half;* the top is 8 feet diameter, and there are four filling holes. The greatest produce of his original furnace, he states to have been 74 tons per

week, while that of the improved one has reached 115 tons in one week. This is by *cold blast*, with a density of only 1 lb. 13 oz. per inch at the tuyere.

Mr. Gibbons' opinion, like that of many others is, that with the hot blast, the shape, or the size, has very little effect; but that this is not the case, is now well known.

3rd. *Influence of Blast.*—In cold blast working, some practical men hold that the density of the blast should not exceed 2 lbs. to the inch, while others work it as high as 3 lbs. to the inch, or even more. In re-smelting also in the cupola, many prefer the fanners, which give a much *softer* blast than the old method of the cylinder; while others, after having tried the fanners, have returned to the original and *stronger* blast of the cylinder. We cannot suppose that this is altogether fancy, or prejudice; I have no doubt that the differences of the material subjected to the blast, is the cause, in a great measure, of such opposite results.

At Lightmoor the various requirements of blast to make the best yield, with the different coals, were striking; coal No. 1, (of table I,) which is the best, required a considerably less dense blast than the inferior, No. 2, (yard coal.) Indeed, blast, either in volume or pressure, seemed to be of little consequence to the working of the clod coal—from 1¾ lbs. to 2¾ lbs. to the inch—the yield was not affected, the only difference being a slight increase of quantity. Nor did diffusing the blast by a number of tuyeres seem to make a material difference. It is a fact that, with this coal, and a furnace of ordinary dimensions, 60 tons of iron have been made in a week by *one blast pipe only*, the nozzle only 3 inches diameter, or 9 circular inches of blast.

On the other hand, the inferior, or, as they are called there, the "sulphury" coals, required a highly compressed blast to bring them to their best yield—one under 2½ lbs. to the inch gave very inferior results; compare this with Mr. Gibbons' result—his materials seem well adapted for cold blast working—and we find density of blast not a great object to them. 1 lb. 13 oz. only was his density at tuyeres, and this continued the same, although he doubled the capacity of his furnace.

These general facts seem to contradict the opinion, that the whole *rationale* of the effect of the hot blast is merely a decrease in the density of the blast, because, with the inferior material, which requires with *cold* blast the *greatest* density, the *hot* blast has the greatest and *best effect*.

Those who are acquainted with cold blast working, know that most materials work best with what is technically called a "snuff" at the tuyeres; and to form this it is usual to blow a few inches below the surface of the scoria, which floats on the iron in the hearth. The "snuff" is a kind of arched tube formed by the cinder at the end of the tuyere in the inside of the furnace, and through which the blast passes. Now it appears to me that this natural muzzle of cinder has a great deal to do in diffusing the blast in contact with the material; and, mark that those materials which, from inferiority, required blast

of the greatest density, gave the greatest trouble at the tuyeres, and presented practical difficulties in the "snuffing," which required a great pressure mechanically to overcome, and clear a way for the passage of the blast upwards; for *such* materials, from what cause I know not, always work with great uncertainty at the tuyeres—sometimes having a tendency to stop up entirely, at others not snuffing at all.

If this practical difficulty could be avoided, perhaps the bad material might give a better result with a soft blast than we found it to do.

As regards the blast's density, when used hot, it must of necessity be much less than cold; for the quantity of air injected from the blowing apparatus, is, generally speaking, no more with hot blast than with cold, while the area of the nose-pipes, taken together, is doubled, or trebled. The diffusion of the blast by increasing the number of nose-pipes, and disposing them around the hearth, has produced great increase in make; and in some cases, by this, together with increased shape, coals have been brought to work raw, which, with the first hot blast trials, could only be used when coked.

It seems agreed on all hands, the greater the number of the tuyeres around the hearth, the better; and as I am aware that practical difficulties occur in doing so by the furnace "blowing forward," I will state a simple plan by which we overcame the difficulty. In building our furnace we had a round base, as is now common, but instead of the usual four opening, we made five—one for the opening of the hearth, and *four for tuyeres.* By this method the blast from one tuyere does not blow against the other, and neither of them blow directly to the fore part; thus *eight tuyeres* may be used—two at each tuyere side.

More pressure is required even with hot blast to work some materials than others. For instance, we required but 2½ lbs. per inch in North Staffordshire, when working coke, but with coal, 3 lbs. per inch, with much greater heating surface, was required. The quantity of blast required here was very great. Blowing at four sides, we injected into a furnace fully 3000 cubic feet of air per minute, and heated to a high temperature. If this pressure happened at any time to be reduced, the effect was immediately perceptible, or if one of the tuyeres was taken off, a falling off in quantity and yield was the immediate consequence. The materials were, as I have before noticed, the worst I ever saw; both coals and iron stone being sulphury.

I will give only one other fact, a very extraordinary one, showing a most peculiar effect produced by a *simple increase of temperature,* at a work near Tipton, where the materials are of fair quality. The furnace upon which the experiment was made is only 11½ feet at "bosh," and 45 feet high, worked with raw coal, and hot blast; it produced 100 tons a week, being blown with five tuyeres, of 3 inches diameter each.

The cross pipes of the heating apparatus were four inches diameter, and one apparatus supplied all the tuyeres.

The alteration was this: the number of heating pipes was increased, the cross pipes increased in size from 4 inches diameter, to 7 inches diameter, and the main pipes also enlarged; the top of the furnace widened from 4 feet diameter to 7 feet diameter; the number of tuyeres increased from five to six, two on each side, and two at back, each of 3½ inches diameter; a new steam cylinder of greater power was put to the blast engine, but the blast one was kept at the same size.

The consequence is, that more than 150 tons of iron have been produced at this furnace in one week, with an improvement of yield, and the *engine goes no more strokes*, showing that actually no more *air* is forced into the furnace than when making only 100 tons a week, (two-thirds of present quantity,) although with a much greater area of nozzles.

TABLE No. II.

	Pressure in pounds.	Total area of nose pipes in circular inches.	Capacity of furnaces, cubic feet.	We'kly make of Iron.
COLD BLAST.				
Works near Glasgow,	3	12.5	2500	45 tns.
Lightmoor Works, with *bad* material.	3	15	2000	45 "
Same, with *good* material,	2½	12.5		65 "
Fenton Park, with *bad* material,	2½	12.5	1000	25 "
Corbyns Hall, Mr. Gibbons, *good* material,	2	18.2	4000	115 "
HOT BLAST.				
Works near Glasgow,	2¼	18	2500	60 "
Fenton Park Works,	2½	27	1000	40 "
The same, with different shape of furnace.	3	36	2500	70 "
Tipton, (a Work at)	2¼	45	2200	100 "
The same, with increased heating surface, but no greater *quantity* of blast.	2¼	72	2600	150 "

I give a short table of the pressure of blast, which shows that the quantity of blast bears no constant proportion to the capacity of the furnace, nor to the make. The results given from the Glasgow furnaces, are taken from data by M. Dufrenoy, in 1833; but since that period, the areas of nose pipes, and the number, and, consequently, the make, have been increased as at other places.

This table shows that the quantity of blast varies with different material to produce the same quantity of iron, especially with cold blast; with hot blast the *areas* bear little relation to the actual quantity of air injected, which cannot be arrived at without the capacity of the blowing cylinder, and speed of engines.

The tables and statements are much more general than I could have wished; at the same time I think they sufficiently show that, 1st. There is a remarkable difference in the material of different strata in the same coal fields; 2nd. That modification of shape and alteration of capacity have a very considerable effect; and 3rd. That the effect of blast is very various with different materials; that an alteration of its temperature, with certain coals, produces a saving of, in some cases, one-half, in others two-thirds of the quantity, while with other coals the difference is scarcely perceptible, and the quantity of blast has little relation to the quantity, or bulk, of material acted upon.

The improvements in iron smelting have been effected simply by the observation, and consequent successive trials, of practical men; they have been the result of no principle previously established—no theory obtained from the laboratory of the chemist—and further, I think it cannot be denied that the anomalies apparent under each condition into which I have divided my results, present a problem which, as far as chemical analysis has yet gone, it is difficult to solve. And it must surely be admitted, that had these conditions been previously laid down to any one well acquainted, theoretically, or practically, or both, with the manufacture of iron, together with a careful analysis of the material here referred to, he would never have predicated such results as have in reality accrued.

That the want of a guiding principle is greatly felt, and its attainment greatly to be desired, needs not to be set forth; and as there is no effect without a cause, I do not see that the number of apparent contradictions in these ought to make us, in the least, despair of ultimately attaining, by the powerful aid of science, a satisfactory rationale of the whole case. This, however, will never be done by avoiding the question—by taking a partial view of facts.

Glasgow Mech. & Eng. Mag.

On Artesian Wells. By Admiral Sir David Milne, G. C. B.

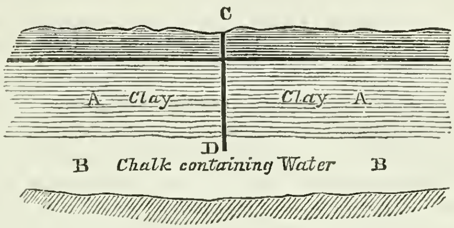
The theory of Artesian Wells, maintained by Buckland, Arago, and other first rate authorities, rests on a circumstance which seems to me liable to some doubt, and which I now mean briefly to consider, viz., the necessity of the water which ascends through the bore, having previously descended, or filtered through the earth, from some higher ground in the neighborhood.

But it is a well known fact, that in the vicinity of many artesian wells there are no hills at all, nor any particular elevation of the earth's surface; and the supporters of the now existing theory are driven to the necessity of seeking for these heights at any supposable distance. M. Arago, indeed, himself says, "that they must be sought for even beyond the sphere of vision, at the distance of forty, eighty, or hundred and eighty miles, or even more, if necessary."

Many years ago it struck me that a much more probable, and less complicated theory of artesian wells might be maintained, and which does not imply the necessity for there being any higher ground in the

neighborhood, none, indeed, at all higher than the mouth of the tube inserted in the bore for the supply of the springs.

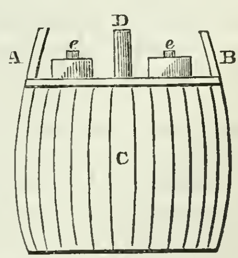
To elucidate my theory, let us suppose, immediately under the surface where the bore is made, a superincumbent mass of clay—such as the London clay—lying over chalk, or other formation, containing water. A diagram will more clearly show this.



A, denotes the bed of clay, a pipe is made to penetrate it from C to D, where it reaches B, a bed of chalk containing water. On known hydraulic principles it is demonstrative, that the instant the pipe C D, reaches the stratum, B, containing water, the water will be immediately forced up the pipe from the pressure of the superincumbent mass of clay, and will rise to the surface of the earth at the point C.

As another illustration, let us suppose that the bed of clay rested nearly horizontally on the lower strata containing water, and it will be seen that the same result would follow. The moment that vent was given by the bore to the water, it would be forced by the superincumbent weight to rise in the tube. The superincumbent strata will, as the water flows up, sink down, and continue to force up the water so long as any remains at the bottom of the bore. Indeed, the same reasoning applies to the continuance of the supply of water, even if we admit it as coming from a higher level. To support the latter theory, however, we have seen that it is necessary to admit the dubious fact, of the required water coming from heights sometimes at almost inconceivable distances; whereas, by the former, this difficulty is entirely got over.

The more distinctly to illustrate this, let us suppose a cask, or wooden box, C, filled with water, until it reaches the cover, A B, which is tightly fitted as a top. Then insert a hollow tube, D, through the cover, A B. When the pressure of the cover is increased by the addition of the weights, *e e*, the water will rise to the top of the tube, D, and it will continue to overflow as long as the pressure is made, or the supply continues. The same principles apply exactly to the rise of water, by superincumbent pressure, from the bed of clay. If it be argued against this theory, that the supply of water would, in time, cease, it may be answered, that the same argument obtains, and with equal force, against the other; for whether the water comes from a higher



level, or only from a free level, it should be remembered that it has been admitted by the best authorities, that artesian wells are sensibly affected by long continued droughts.

In confirmation of these views, and as a familiar practical illustration, I may be permitted to mention, that when the present basin was being constructed in Portsmouth dockyard, in 1796 or 1797, the piles first driven were 15 feet in length. From their length, these passed entirely through the bed of clay into sand containing water. The consequence was, that the water squirted up in all directions from the subjacent reservoir, and as it was uncertain to what extent the piles would sink, before they reached any solid stratum, it was resolved to shorten the piles, so that they might not pass through the clay at all; and the old holes were with some difficulty plugged up. Some years afterwards, the dockheads of one of the principal docks gave way, and sunk considerably; nor could any of the officers of the yard account for the occurrence. It happened at this very time, that, with the late Commissioner Sir George Grey, I was examining the docks; and, recollecting the circumstance which rendered it necessary to cause the piles to be shortened, namely, their having penetrated into the sand containing water, it occurred to me to ask Sir George if any wells were, at the time, being sunk in the neighborhood? His reply immediately was, that "certainly, workmen were then sinking for water near the officers' houses." Upon which I remarked, that if the sinking of the well was not stopped, other parts of the masonry of the docks would most assuredly give way; and that no wells should be allowed to be sunk near the dockyard, as, by giving vent to the water in the sand under the clay, the foundations of the buildings must necessarily be effected. This hint was, I believe, attended to, and the sinking of the well was stopped. In situations such as these, the insertion of a pipe through the clay would afford the supply of water with much more safety, the drain being less, and much more gradual.

Indeed, I can perceive no difficulty adhering, to the theory of artesian wells now propounded, which does not, with equal force adhere to the other; and it is free from many objections, to which it is liable. When we read, in Dr. Buckland, (p. 560,) when treating of this subject, that "by similar wells, it is probable that water may be raised to the surface of many parts of the sandy deserts of Africa and Asia," we may be well tempted to exclaim, "And where is the level there from which it can come?"

If the theory I have suggested be well founded, it must be obvious, that in a great town, or the neighborhood of it, built on a mass of clay, through which wells are sunk, there will be a constant, though probably a very slow and gradual, subsiding of the surface. Such situations would, therefore, be ill adapted for permanent observatories for astronomical purposes; as a subsidence of the ground, inappreciable on the earth itself, may produce sensible errors in observations of the heavenly bodies. May not some of the anomalous results obtained at observatories, be ascribed to this cause?

Edin. New Philos. Journ.

On the Results of the Panary Fermentation, and on the Nutritive Values of the Bread and Flour of different countries. By Robert D. Thomson, M. D., *Conductor of the Laboratory, and of the Classes of Practical Chemistry in the University of Glasgow.**

Several years have elapsed since the author first had his attention directed to the comparative chemical and medical values of fermented and unfermented bread as articles of food. The common idea, which yielded the palm of superiority to the former, did not appear to be based on solid data, and it was, therefore, considered desirable, that in reference to a subject of such importance to the nourishment of man, the arguments in favor of such an opinion should be subjected to a careful examination. Judging *à priori* it did not seem evident that flour should become more wholesome by the destruction of one of its important elements, or that the vesicular condition of bread could alone be gained by a process of fermentation.

When a piece of dough is taken in the hand, being adhesive, and closely pressed together, it feels heavy, and if swallowed in the raw state, it would prove indigestible to the majority of individuals. This would occur from its compact nature, and from the absence of that disintegration of its particles, which is the primary step in digestion. But if the same dough were subjected for a sufficient length of time to the elevated temperature of a baker's oven, (450°) its relation to the digestive powers of the stomach would be changed, because the water to which it owed its tenacity would be expelled, and the only obstacle to its complete division, and consequent subserviency to the solvent powers of the animal system would be removed. This view of the case is fully borne out by a reference to the form in which the flour of the various species of *Cerealia* is employed as an article of food by different nations. By the peasantry of Scotland, barley-bread, oat-cakes, peas-bread, or a mixture of peas and barley-bread, and also potatoe-bread mixed with flour, are all very generally employed in an unfermented form, with an effect the reverse of injurious to health. With such an experience under our daily observation, it is almost superfluous to remark, that the Jew does not labor under indigestion when he has substituted, during his passover, unleavened cakes for his usual fermented bread—that biscuits are even employed when fermented bread is not considered sufficiently digestible for the sick, and that the inhabitants of the northern parts of India, and of Affghanistan, very generally use unfermented cakes, similar to the *scones* of Scotland.

Such then being sufficient evidence in favor of the wholesomeness of unfermented bread, it becomes important to discover in what respect it differs from fermented bread. Bread making being a chemical process, it is from chemistry alone that we can expect a solution of this question. In the production of fermented bread, a certain quantity of flour, water, and yeast are mixed together, and formed into a

*Abstract of papers read before the Philosophical Society of Glasgow, 14th February, 1842, and 26th April, 1843; and now communicated by the author.

dough, or paste, which is allowed to ferment for a certain time at the expense of the sugar of the flour. The mass is then exposed in an oven to an elevated temperature, which puts a period to the fermentation, expands the carbonic acid resulting from the decomposed sugar, and the air contained in the bread, and expels the alcohol formed, and all the water capable of being removed by the heat employed. The result, gained by this process, the author considers to be merely the expansion of the particles of which the loaf is composed, so as to render the mass more readily divisible by the preparatory digestive organs. But as this object is gained at a sacrifice of the integrity of the flour, it becomes a matter of interest to ascertain the amount of loss sustained in the process. To determine this point, the author had comparative experiments made upon a large scale with fermented and unfermented bread. The latter was raised by means of carbonic acid generated by chemical means in the dough; but to understand the circumstances, some preliminary explanation is necessary.

Mr. Henry, of Manchester, at the end of the last century, suggested the idea of mixing dough with carbonate of soda, and muriatic acid, so as to disengage carbonic acid in imitation of the usual effect of fermentation; but with this advantage, that the integrity of the flour was preserved, and that the elements of the common salt required as a seasoner of the bread, were thus introduced, and the salt formed in the dough. Dr. Hugh Colquhoun, first, it is believed, carried this suggestion into practice, in 1826, and made numerous experiments on bread making.* But it was not till within a very few years, that the idea of using bread thus baked on a large scale was carried into execution. From the result of several experiments made at the author's request, it appears that upon an average there is a great loss sustained by flour when it is fermented. In comparison with the bread raised by carbonate of soda, and muriatic acid, there is a loss in the sack of flour of 30 lbs. 13 oz.; or, in round numbers, a sack of flour would produce 107 loaves of unfermented bread, and only 100 of fermented bread, of the same weight. Hence, it appears, that by the common process of fermented baking, in the sack of flour, 7 loaves, or $6\frac{1}{2}$ per cent. of the flour, are driven into the air and lost.† An important question now arises from the consideration of the result of this experiment, viz., does the loss arise entirely from the decomposition of sugar, or is any other element of the flour attacked?

It appears from a mean of 8 analyses of wheat flour from different parts of Europe, by Vauquelin, that the quantity of sugar contained in flour amounts to 5.61 per cent. But it is obvious, that as the quantity lost by baking exceeded this amount by nearly 1 per cent., the loss cannot be accounted for by the removal merely of the ready formed sugar of the flour. We must either ascribe this extra loss to a conversion of a portion of the gum of the flour into sugar, and its

* Annals of Philosophy, N. S., vol. xii.

† In consequence of these and other facts brought forward by the author, the unfermented system of baking has been introduced into many of the unions in England, where, he believes, it has been found that he has not overrated the saving, which the above experiments would indicate to be upwards of a fifteenth.

decomposition by means of the ferment, or we must attribute it to the action of the yeast upon another element of the flour; and if we admit that yeast is generated during the panary fermentation, then the conclusion would be inevitable that another element of the flour, besides the sugar, or gum, has been affected. For Liebig has well illustrated the fact, that when yeast is added to wort, ferment is formed at the expense of the gluten, while the sugar is decomposed into alcohol and carbonic acid. Now, in the panary fermentation, which is precisely similar to the fermentation of wort, we might naturally expect that the gluten of the flour would be attacked to reproduce yeast.

The author has succeeded in forming a wholesome and palatable bread, by the employment of ammoniacal alum, and carbonate of ammonia, or soda, as a substitute for yeast. In this process the alum is destroyed by the heat; the bread is vesicular and white, and rises, according to the judgment of the baker, as well as fermented bread. It is obvious that none of the ingredients added can affect the integrity of the constituents of the flour, an occurrence which possibly may happen in the preparation of bread by the common process of fermentation, as has been shown, even to the azotized constituents. The disadvantage of such a deterioration is sufficiently evident if we view these principles as the source of nutrition in flour.

Lond., Edin. & Dub. Phil. Mag.

[Note.—The remaining portion of this article is devoted to a comparison of the value of different flours founded upon a chemical analysis; the result of which is that the flour from the United States falls far below all others in the quantity of nutritive matter contained in it—one of the European flours (Naumburg) being fifty per cent. more valuable. Would it not be worth while to inquire how far this result was affected by bone-dust, which, if our information upon this side of the Atlantic be correct, is a favorite adulteration in England and Scotland.] Com. Pub.

On the use of Larch Bark in Tanning. From an article on the "Examination of Astringent Substances, by J. Stenhouse, Esq."

The bark of the larch is employed in Scotland to some extent in tanning. The quantity of tannin it contains is considerable, but the leather made with it is of inferior quality. The aqueous solution of the bark is strongly acid to test paper, and has at first a pale yellow color, which exposure to the air renders brownish-red; it gives a copious fawn colored precipitate with gelatine, but none with tartar-emetic. With the sulphate, chloride and nitrate of iron, it gives olive-green precipitates. Acetate of iron throws it down of a bluish-purple color. Sulphuric acid precipitates it of a reddish-yellow color. When boiled with the acid it dissolves, and the liquid assumes a fine scarlet color, like the infusion of Brazil wood. The altered tannin precipitates on cooling in beautiful red flocks, as it is but little soluble in cold water. It is very soluble in alcohol and alkalies, and its solutions

have a rich scarlet color, which is the most characteristic reaction of this species of tannin. Larch bark also contains a good deal of mucilage and resinous matter, Birch bark, alder bark, and tormentil root, contain, all of them, considerable quantities of tannin, which closely resemble that of larch bark. All these species of tannin are readily precipitated by gelatine, but not by tartar-emetic. They give olive-green precipitates with most of the salts of iron except the acetate, which throws them down of a bluish-purple color, which, on standing, changes to a leaden-grey. When boiled with alkalies they immediately assume a fine red color, but they differ from the tannin of the larch in not being reddened by sulphuric acid. I think it unnecessary to go into more minute details respecting them, as I have been unable to derive from them any determinate, or crystaline, compounds. I shall leave this subject, therefore, for the present with one or two general observations.

The great difficulty of examining the different species of tannin with a view to classifying them, is chiefly owing to their amorphous nature, to the great similarity of their properties, and to the circumstance, that, except in the case of nut-galls and shumac, the products of their decomposition are of a very indeterminate character. We think, however, that there are good grounds for believing that both nut-galls and shumac contain the same species of tannin, for the effects of reagents upon it are exactly the same, and the products of its decomposition, when boiled with either sulphuric, or muriatic, acid, when destructively distilled, or when left to spontaneous decomposition, are, in every instance, identical, from whichever of these sources it has been derived. It is remarkable also that in so many instances, in eight cases out of ten which I have examined, the species of tannin which give bluish-black precipitates with protosulphate of iron, are accompanied with larger, or smaller, quantities of gallic acid. In the present state of our knowledge it is impossible to say whether the gallic acid has originally existed in these substances, or has resulted from the decomposition of the tannin they contain. In the case of galls and shumac, the latter opinion is probable enough, as we are easily able to effect this change by artificial means, and it also, as is well known, occurs spontaneously. In the case of the other species of tannin, however, we are still unacquainted with any instance of a similar transformation. It is to be hoped that subsequent researches may yet throw light on this very obscure subject. It is also rather singular, that in the case of some of those species of tannin which give green precipitates with salts of iron, a somewhat similar circumstance occurs. Thus the tannin of catechu is accompanied by a crystaline acid body, catechine, which also gives green precipitates with salts of iron. I have likewise observed that in the case of infusions of birch bark, alder bark, &c., when the whole of the tannin they contain had been removed by gelatine, the clear liquid when filtered still contained a substance which precipitated salts of iron olive-green, just as the tannin had done, and which threw down salts of lead as copious dark yellow precipitates. When the lead salts were decomposed by sulphuretted hydrogen, I obtained an amorphous acid sub-

stance of a bright yellow color, which was soluble in water, alcohol, and æther, but which did not appear to be crystalizable.

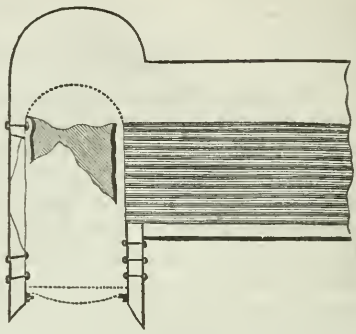
Ibid.

Explosion of the Telegraph Steamer.

This melancholy catastrophe—the most serious which has occurred upon the Clyde since the disastrous affair of the "Comet," in 1826—took place at the quay of Helensburgh, on Monday the 26th of March. The circumstances attending it are already widely and well known; but in order to preserve the facts, it may be briefly stated that the vessel had just landed her passengers from Glasgow and Greenock, and was in the act of backing out from the quay on her way to the Gareloch, when the disaster arrested her further progress. The engine had made one stroke, and was in the act of making a second, when, for a moment, a hissing noise was heard; this was followed, almost instantly, by a terrific crash of no comparable kind; and high in air, amidst volumes of steam and smoke, were to be seen the boiler, engine, funnel, and a thousand fragmentary portions of the unfortunate vessel and her furniture, commingled with human victims in one appaling picture of destruction. The engine and boiler, when they rose, turned over longitudinally, and, passing right over the heads of two men who were seated in a four-oared gig, waiting for the owner to come on board, fell into the water at a distance of 60 yards from their position in the vessel. They did not, however, instantly sink in coming into contact with the water, but skipped some length further along the surface, pouring forth, in the mean time, large quantities of steam. When the steam and smoke had cleared off, the vessel was found to be a total wreck, in the most literal sense of the term; among its broken timbers were to be seen the bodies of the dead and dying, and around, upon the water, were several survivors clinging to floating fragments of beams and boards. Immediately boats were out picking up the sufferers, and in a few minutes thirteen dead bodies, and as many severely wounded individuals, lay stretched in the rooms of the inn. Six more have since been added to the catalogue of the dead.

The construction of the Telegraph was quite a novelty even on the Clyde. She was clinker built, measured 120 feet in length, by 14 feet of beam, and was considered of 32 tons. Above and between the cabin and steerage there was a high elevation, on which was placed the wheel, so that the steersman, from his commanding situation, might keep a good look out; the helm was moved by chains running along the bulwarks, one on each side of the stern. Everything was contrived with a view to swift sailing—professedly, indeed, to compete with the Glasgow and Greenock Railway—and, in some measure, the expectations of her owners had been realized. Besides being herself of the lightest construction, she was propelled by an engine, which, with its boiler, weighed only eight tons; and was calculated, at a moderate pressure of steam, to work to 50 horse-power.

The whole was in imitation of the construction employed on railways, and worked, of course, on the high pressure principle. The boiler being a tubular one, as seen in the annexed figure, it was necessary to feed it with fresh water, and being unable to obtain fresh water by the pumps below Dumbarton, it was necessary to have tanks to contain a supply sufficient to furnish steam to carry her to Gareloch, where the tanks were again filled. The boiler was provided with three cocks, for ascertaining the quantity of water in it, besides a glass gauge; and had two safety-valves, both weighted by Salter's balance.



There has been much conjecture as to the cause which gave rise to the catastrophe. Some hold that it is to be attributed solely to the simple over pressure of steam, and the over loading of the valves; and others that it is to be ascribed to the water having been allowed to become too low, and the plates red hot, water being thrown upon these either by the feed-pump, or simply by the movement of the vessel, a sudden evolution of steam might take place, sufficiently powerful to produce explosion; or, according to another opinion, "the steam and water might be decomposed, and instantaneously generate a gas (hydrogen) possessing all the explosive force of gunpowder." The public verdict seems to have settled down between these latter hypotheses, into which it has been guided by the report of an examination of the condition of the boiler after the explosion, made, we are informed, under the direction of Mr. Rowand, of the Atlas Works, Glasgow, where the engine and boiler were made, and furnished by him to one of the local newspapers.* It proceeds:—"The accident has evidently been occasioned by the want of a due

* We have been informed that Mr. Rowand did not expect his name to appear in the report—that its appearance, in fact, was altogether an editorial blunder; but we really cannot sympathize with Mr. R. in that matter; if the investigation was carefully conducted, and the report faithfully given, there could be no harm in appending his name to the statement, as a guarantee to the public for its correctness. It is only under these circumstances that we can suppose Mr. R. to have lent his aid at all to put into circulation a report such as that quoted above; and although we cannot reconcile some statements in it, with the result of our own examination, we do not, for a moment, suppose that Mr. R. could have any intention of producing, even anonymously, a false opinion. It is, however, to be remarked, that it ought not to have been left to Mr. Rowand, or any other interested party, to report on the subject. It was the business of the local authorities to have appointed inspectors immediately on the fact of the disaster coming to their knowledge; and to have prohibited the removal, or disturbance of a single article, until a thorough examination had been leisurely and carefully gone through, and every fact noted, that could tend to elicit information as to the causes which led to the catastrophe. Somebody observes, that "occasional explosions" will occur; yet it is certainly very desirable that they occur as rarely as possible; and the way to make them less frequent, is to profit by the circumstances of all preceding instances. But if the facts are allowed thus to be obliterated, and glossed over without inquiry, or if they are allowed to be put forth in a form which gives them no practical bearing, the lesson is lost, and we are as ready as ever to take another. It may be said that such cases stimulate the tender

quantity of water in the boiler, as the plates in the crown, or cover, of the fire box have been red hot. On examination we find that the plates were riven completely across, as shown in the section above, the dotted line being the original position of the crown, and the heat has been so great that though the fire-box, or furnace, is only about 3 ft. 3 ins. wide, the plates are stretched, or expanded, so as to measure 4 ft.; and there are also on the plates several large blisters, which could only be the result of the intense heat. The violence of the explosion has been so great as to tear one of the corners of the fire-box a considerable way down, the plates at the corner being 5-8ths of an inch thick. The same rent goes through a solid bar 3 inches by 2. So far as can be seen, none of the tubes are injured. The fire-box was made of the best Lowmoor plate, of the following thicknesses:—Tube plate 5-8th inch, back ½ inch, crown 7-16ths. Tube and back plates welded."

That this report could have been published with a view to mislead public opinion, we cannot for a moment believe; yet a very careful inspection of the ruptured parts of the boiler leads us to a very different conclusion, as to the real cause of the explosion. That the plate forming the crown of the fire-box *had been heated*, we readily admit; it bears evidence of the fact; but that it was red hot at the instant of rupture, is inadmissible. On examining the blister marks upon the plate, we had no difficulty in concluding that the injury was of anterior date, and we were soon furnished with sufficient evidence that the cover had been "burned" at least twice previous to the catastrophe. This sufficiently accounts for the blister marks observed; and perhaps for the slight discrepancy between the thickness stated by Mr. Rowand, and that found by ourselves. In the report, it will be observed, the crown is given as a plate of 7-16ths, (when new?) whereas to us it barely measured 3-8ths, (that is, fully a sixteenth less,) *and we did not observe that it had been stayed.* By the way, is this usual in boilers similar in size to that of the Telegraph? In evidence of the heated condition of the crown, at the instant of rupture, it is stated in the report quoted, that the plates are stretched from three feet three inches to four feet. How Mr. Rowand came to such a conclusion, we cannot comprehend. As the crown, in its original position, formed a segment of a sphere, we can readily see that the linear measure of the ruptured plates would be greater than the chord which formed the diameter of the fire-box; and taking this into consideration, we

feelings of our nature, which might, without such salutary exercise, sink into dormancy. The circumstances, however, do not admit of levity; and we have certainly no inclination to indulge in any remark that might lead to the supposition that we regard the luke-warmness of the authorities, in this instance, as a matter of trivial importance; we look upon it as culpable negligence, admitting of no palliation. It is indeed stated, that "by direction of the authorities, certain professional men *are to* report to the sheriff on the subject." Allowing this statement to be well founded, it can hardly be taken in extenuation. Supposing these "certain professional men" to find their way, "by appointment," at some early day, to the quay of Helensburgh—what parts, or particles, of the exploded Telegraph remain for them to inspect? Every fragment has been assiduously picked up and removed, and the professional gentlemen are left to make up the best report they can, from such unprofessional opinions as they may be able to collect at second-hand.

have not the slightest hesitation in stating, that the superficial area of the whole cover is not increased a single inch.

There is, however, a more potent fact bearing against the opinion that the crown was in an intensely heated condition at the instant of explosion; the lead plug, put in for the express purpose of being melted before the plate could arrive at a dangerously high temperature, we found quite entire, and showing no symptoms of fusion. It is indeed believed, that when lead has been used under these circumstances for a length of time, it becomes oxidized, and requires a much higher temperature than 612° Fahr. to fuse it. It is for this reason, among others, that common solder is now used for such plugs, in preference to lead: it does not oxidate so speedily, and it fuses, moreover, at a lower temperature, and is, therefore, most decidedly to be preferred. On examining the plug, however, we found it far less oxidized than we had been led to expect. Whether it had been lately renewed we could not learn, but most certainly there was not oxide enough upon it to elevate its melting point ten degrees of Fahrenheit's scale.

But while we thus come to the settled conclusion, that the crown was not in a red hot state at the instant of explosion, we yet admit that it may have been over-heated within the range of temperature in which lead is solid; and that the explosion may, therefore, possibly be referable to a deficiency of water in the boiler. At the time we examined the boiler, it was ebb water, and the fire-box was quite exposed; but from the position in which the boiler itself was lying, we were unable to gain any information as to the state of the valves, and the amount of pressure at which they were weighted. This is not very much to be regretted, as, from the condition of the parts which we were able to examine, we had no difficulty in coming to the conclusion, that the explosion was caused by over-pressure of steam. The only inquiry which arises, is involved in the question—did this pressure proceed from an injudicious loading of the valves, or was such an amount of steam instantaneously generated, that, added to the amount already in the boiler, it produced a pressure too great for the cohesive strength of the crown plates?

That the explosion was the simple effect of over-pressure of steam, caused by over-loading the valves, might perhaps be argued upon the single fact, that during the slow working of the engine in approaching the quay of Helensburgh, and while remaining there, no steam was allowed to escape; and we believe that it was the practice, at all times, to raise the steam to a very high pressure in the boiler, before starting the engine. The fact of the steam being thus reserved, leads very directly to the conclusion, that a high pressure must have been accumulated in the boiler prior to the rupture taking place. Here, however, a question presents itself—why did the boiler explode when a portion of the steam was being withdrawn to set the engine in motion?—why not before, when the strain must have been more intense? These questions apply to nearly all recorded explosions of steam boilers. With very few exceptions, the rupture has immediately followed the admission of the steam upon the piston; and the

fact admits of a very easy explanation. On the exit of a portion of steam from the boiler, there is instantaneously generated a corresponding, or rather, there is reason to suppose, a greater quantity; for the undulatory motion given to the body of steam in the boiler, by opening the steam-cock, will, for an instant, withdraw a part of the pressure from the surface of the water, which will, so to speak, embrace the moment to send off an amount of steam corresponding to its temperature, and the amount of pressure removed. But the steam wave produced, in the first instance, in the direction of the steam pipe, being reflected back from the top of the boiler, must produce upon the bottom a greater pressure than before existed, when the whole contents were in a quiescent state. Add to this a quantity of steam, which we can easily suppose to be generated by waves of water laving high upon the heated sides of the boiler, consequent on the motion of the vessel; and there can be little difficulty in seeing why rupture may be produced under the circumstance of the engine starting, in a boiler already distended by steam, to the full strength of its vulnerable points. This explanation comprehends the celebrated case of the explosion of Messrs. Ferey's boiler, at Essonne, in France, which took place on opening the safety-valve, and likewise the explosion of two of Mr. Steele's three boilers at Lyons. In this case, these steamboat boilers were connected together, and the safety valve was fastened down to increase the pressure of steam. Shortly after one boiler exploded, and broke the connecting pipes. This, according to the received opinion—that by withdrawing a portion of steam, the pressure and danger are thereby instantly diminished—ought to have saved the other two boilers, by acting as safety-valves to them; they nevertheless exploded in succession.

With the facts before us of the retention of the steam, and the previously weak state of the crown plate—the only part of the boiler ruptured—there cannot exist much difficulty in comprehending the case before us. There is little necessity for supposing a deficiency of water in the boiler, and certainly none for supposing the crown to have been red hot at the time of rupture. It is true that the catastrophe may be explained on such a supposition—not by the decomposition of water, and the generation of hydrogen gas. We feel very confident that no case of explosion, under like circumstances, can be traced to such a cause. But, as already noticed, heated plates, by having a quantity of water laved upon them, readily give out their heat, and create an additional quantity of steam, and, in consequence, an additional aggregate pressure within the boiler. We are not, however, prepared to believe that the danger of over-heating boilers lies in the quantity of steam which is thereby produced on the admission of water;—the danger is to be apprehended from the suddenness with which it is produced. The heat even of red hot iron is small when viewed in connexion with the quantity of heat requisite to convert water into steam; but being a good conductor, it parts with its heat to the water with great facility, and under the conditions supposed, we can readily imagine that it will send off from its surface a volume of steam of great momentary elasticity. It is, moreover, to

be remarked, that a sudden development of steam in a boiler will exert its force, in the first instance, against the bottom; and it is only when this has sustained the concentrated shock without injury, that the force is reverberated, and allowed to distribute itself over the whole interior. Many cases of explosion, where a portion of incrustation had become loosened, and allowed the water suddenly to come into contact with an over-heated plate, may be referred directly to the instantaneous expenditure of the force at that point; and even under ordinary circumstances, the bottom—upon which the steam forms—sustains a greater amount of pressure than any equal superior surface.

Viewing the circumstances, therefore, as we may, we are brought to the conclusions, that the steam force due to the elasticity is expended upon the parts—the bottom and sides, in the first instance,—of a boiler before it comes to act upon the safety-valve, and in all cases where this valve is loaded to such an extent as to retain the steam within, at an elasticity approaching the cohesive strength of the weakest part of the boiler, any undulatory motion communicated to the mass of steam, or any sudden evolution of steam, from whatever cause the one, or the other, may arise, must be attended with great danger of explosion. This danger is thought to be lessened by employing more than one safety-valve, and by enlarging the capacity where one is only used, and there cannot be a doubt but that this is to a certain extent correct; there must at least be sufficient egress provided for the superfluous steam generated; but the only real safety lies in loading the valve—supposing it to be of moderate size—at a minimum of the proved strength of the boiler. To this condition add the no less important one, that the engines and boiler are under the management of trained, intelligent, and properly behaved engineers—men who know something more about an engine than "to put on and off the steam"—and we feel very confident, that disasters, such as that which has engaged our attention, will, in future, be very rare. This is a subject, indeed, which has long since been ready for legislative interference. Parliament is at length beginning to bestir itself in behalf of railway travelers; but the lives of steamboat passengers are equally precious: and surely if it be thought necessary that the engine-man, in the one case, should be able to satisfy a board of examiners, regarding his fitness for the duties incumbent upon him, we have an equal right to expect that those who may rather choose

"To steam it o'er the glassy wave,"

shall not be left to the care of men, whose fitness for their task is left to be judged of by persons, whose first consideration is the payment of the least possible amount of wages. Some have been calling out for the appointment of a government inspector at all our steamboat stations; we go a step further, and would place an accredited inspector in every vessel propelled by a steam engine.

Glasgow Mech. & Eng. Mag.

Description of an improved Tilting Apparatus for emptying Wagons at the termini of railways, shipping places, &c., as used at the Magheramorne Lime Works, Ireland. By James Thomson, Esq., F.R.S.E., M.R.I.A., F.R.S.S.A., Civ. Eng., Glasgow.*

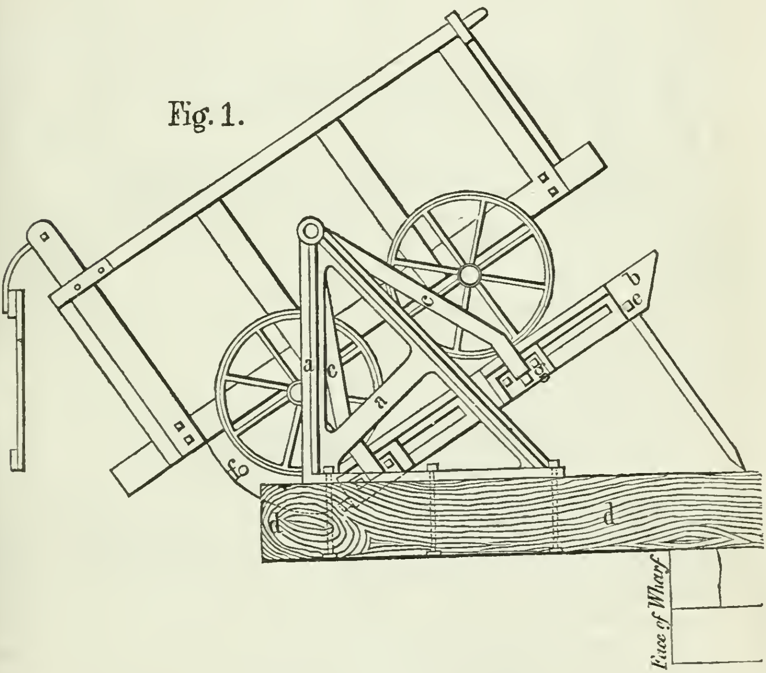
The apparatus may be generally described as consisting of three parts, viz:—

1st. The cast-iron brackets, or quadrants, for supporting the machine, *a, a, a.*

2d. The tilting-frame upon which the wagon is placed *b, b;* and

3d. The malleable iron-swings for suspending the frame to the brackets, *c, c.*

Fig. 1.



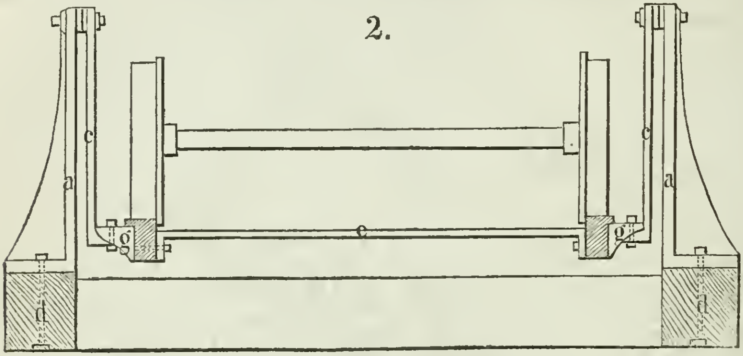
The supporting brackets, *a, a, a,* are bolted to the wooden frame, *d, d,* of a movable shipping platform, by means of which the apparatus is advanced at pleasure, and made to project beyond the wharf, so as to discharge the wagon immediately over the hold of the vessel.

The tilting-frame is formed of two cast-iron cheeks, or sides, as shown in fig. 3, having in each two slots, or grooves, for attaching to the swings, and for adjustment of the apparatus. These sides of the frame are connected together by two flat malleable iron stays, *e, e,* as represented in fig. 2, with two bolts in each end, and a light iron stay, *f,* at the curved ends.

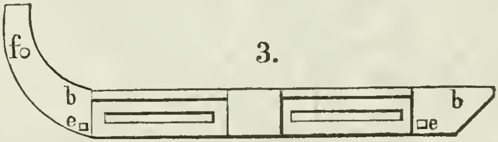
* Read before the Royal Scottish Society of Arts, and working model exhibited 10th of January, 1842, and the Society's Honorary Silver Medal awarded 14th November, 1842.

The swings are attached to the frame by means of snubs, *g*, *g*, which are bolted vertically to the lower ends of the swings, and horizontally to the sides of the frame, the bolts passing through the grooves, or slots, already mentioned, in which they are movable—the upper ends of the swings work upon malleable iron journals fastened in the top of the cast-iron brackets. When the apparatus is properly adjusted, which is done by moving the tilting-frame forward, or backward, upon the swings, by means of the adjusting slots, the wagon, on taking its position, should be so placed that its *centre of gravity may be slightly in advance of the point of suspension.*

2.



3.



The rails to the tilting-frame are laid with a gentle declivity, so that the wagon may be brought upon it with a slight impetus just sufficient to set the frame in motion—the wagon will then immediately fall into a position ready to discharge, as shown in fig. 2, when, by a simple contrivance, which may be effected in various ways, the door of the wagon is opened from behind by a handle and connecting rod communicating with the door latch, and the load discharged.

While loaded, the position of the wagon will of itself remain the same, being in equilibrio; but immediately after it is discharged, and consequently the *centre of gravity thrown behind the point of suspension,* the tendency of the wagon is then to resume the horizontal position, which, however, it is prevented from doing by means of the spur, *h*, until completely emptied—the spur is then disengaged, and the wagon resumes its level position ready to be removed.

The whole operation of discharging a wagon, of whatever weight, is effected with perfect safety and facility in a few seconds, and one very important desideratum is supplied by this apparatus, viz.,—the practicability of *discharging wagons of different dimensions and different sized wheels upon the same tilting-frame.*

The advantages of the apparatus have been fully tested at the Magheramorne Lime Works, in Ireland, where they were first applied, and have since been in constant operation for the last three years, discharging wagons of three tons with 24-inch wheels, and wagons of only 20 cwt. and 20-inch wheels, with perfect facility and expedition—the cost of each apparatus not exceeding from £10 to £11 complete.

Edin. New Philos. Journ.

Manufacture of Oil of Vitriol from Iron Pyrites.

The manufacture of sulphuric acid and soda is carried on conjointly, in a factory at Belgium, in the following manner:—The residua of the roasted pyrites are mixed with an excess of sea salt, having previously ascertained the contents of sulphate of iron contained therein. The mixture is then heated in an appropriate furnace, arranged so as to collect the muriatic acid. The sulphate of soda formed, is obtained by solution and crystalization; the peroxide of iron remaining is separated by elutriation into two parts; the most finely divided is dried and mixed with grease, or palm oil, serving as a lubricator for machinery, for which it is admirably adapted; whilst the coarser portions are made into balls, dried, and used as mineral iron for the puddling furnace. In factories where soda is not made concurrently with sulphuric acid, in place of procuring the sulphate of iron from the roasted pyrites, it will be more advantageous to distil these residua, the sulphate of iron being first dried, so as to obtain the fuming sulphuric acid of Nordhausen, as it is termed. It would be very easy to arrange the apparatus in such a manner that the sulphurous acid, arising from the decomposition of part of the sulphate of iron, should be conducted into leaden receivers, or chambers. By such an arrangement, nothing would be lost, since the colcothar, or peroxide of iron, remaining after the process has been completed, is always available. Lond. Min. Journ.

An Enormous Steam Engine.

An enormous steam engine, by far the largest ever constructed, is now in process of manufacture at Harvey & Co's. foundry, Hayle; the piston-rod, which was forged last week, is 19 feet long, 13 inches diameter in the middle, and 16 inches in the core; and weighs 3 tons 16 cwt. It will work in an 80-inch cylinder, which will stand in the middle of another cylinder, of 144 inches diameter. Five other piston-rods will work between the inner and outer cylinders. We conclude, for this has not been explained to us, that the piston of the external giant cylinder will be perforated in the middle for the 80-inch cylinder to stand in it, and will work between the two. The 80-inch cylinder was cast last week, and the large one will be cast soon. The pumps are to be 64 inches in diameter; a measurement which may afford some idea of the size of the engine. It is intended for draining Hær-

lem Lake, in Holland, and it is expected that other orders for similar engines will be received from the same quarter. It is truly gratifying to us to observe that Cornish engineers still keep so far in advance of all the world, and not less gratifying to see that foreign powers know and can appreciate their excellence. Let this wonder of engineering and mechanical skill be considered, as well as the duty done by our common mine engine; and it must be confessed that our Cornish mechanics are, in this branch, far in advance of every competitor; and we may reasonably hope, as superior merit must be appreciated at last, that our engine foundries will at length have their full share of public and government patronage.

Sherb. and Yeovil (Eng.) Merc.

Bothway's Iron Blocks.

An experiment has been made in Plymouth dockyard, to try the comparative strength of Mr. Bothway's single metal blocks against the rope it is calculated to take, viz., a 3-inch one. A rope of that size was rove in the block, and one end brought to a windlass, and hove on until it broke. A $3\frac{1}{2}$-inch was then tried; though larger than required for such a block, this also gave way; and the last is considered by practical men fully equal to the powers of an 8 or 9 inch block. The iron blocks have also another great recommendation in doing away with the rope strappings, as many serious accidents have occurred by their breaking.

Lond. Mech. Mag.

Street Sweeping by Machinery.

The first exhibition in the Metropolis of the self-loading cart, or street-sweeping machine, which has for some time been in use in Manchester, and is fully described in the "Mechanics' Magazine," No. 1014, took place recently on the wood pavement in Regent street, and attracted crowds of persons to view its very novel apparatus. The cart was drawn by two horses, and attended by a driver, and as it proceeded caused the rotary motion of the wheels to raise the loose soil from the surface of the wood, and deposit it in a vehicle attached to the cart. Proceeding at a moderate rate through Regent street, the cart left behind it a well swept track, which formed a striking contrast with the adjacent ground. It filled itself in the space of six minutes, its power being equal to that of forty men, and its operation being of a three-fold nature—that of sweeping, loading, and carrying at the same time, which, under the old process, formed three distinct operations. Ibid.

An Artesian Well.

The artesian well at the Royal Hospital, Haslar, sunk by Mr. T.

Docwra, manager of the large artesian well now in progress for supplying Southampton with water, has resulted in producing a most abundant supply of water, which has been analyzed by order of the Board of Admiralty, and is found to be of the purest and softest quality. What is most surprising, is, that the water rises through 125 feet of shingle and running sand, which is full of salt water, being affected by the tides. The trouble and difficulty in stopping the salt water out has been entirely overcome. The quantity of water that Mr. Docwra guaranteed to obtain was 12,960 gallons per day, but the actual quantity obtained from the spring, 156 feet deep, was 59,328 gallons per day. This quantity can be pumped every day without reducing the water in the well more than about 40 feet from the surface. Hamp. (Eng.) Ind.

Lunar Occultations.

Lunar Occultations visible in Philadelphia during the month of March, 1844; computed by Mrs. Charlotte S. Downes, from the Elements published with the Occultation list of the United States Almanac.

The Immersions and Emersions are for Philadelphia, mean astronomical time. Im. for Immersion, Em. for Emersion. These abbreviations in *Italics* refer to those Immersions and Emersions which take place on the Moon's dark limb. N. App. for Near Approach.

The angles are for *inverted image*, or as seen in an astronomical telescope, and reckoned from the Moon's North point and from its Vertex around through East, South, West, to North and Vertex again. For direct vision add 180°.

MARCH, 1844.

Day.	H'r.	Min.	Star's name.	Mag.	From North.	From Vertex.
2	9	38	*Im.* *h* Leonis,	6	91°	112°
2	10	46	Em.		328	327
4	17	11	*Im.* *e* Leonis,	4.5	78	30
4	18	22	Em.		328	278
10	13	46	Im. 1974 Bailey,	6	152	195
10	14	27	*Em.*		224	262
10	18	5	N. App. 33 Leonis,	7	☽ N. 0'.1	
21	6	33	*Im.* Bessel,	9	110	57
21	7	31	Em.		256	200
21	7	31	*Im.* Bessel,	8	132	80
21	8	37	Em.		232	182
23	5	22	*Im.* Bessel,	8	108	63
23	6	42	Em.		230	186
23	7	4	N. App. Bessel ☽ N 1'.6	9		
23	10	28	*Im.* Bessel,	8	130	85
	11	17	Em		229	183
23	10	31	*Im.* Bessel,	9	65	15
	11	24	Em.		284	241
30	13	38	*Im.* 6 Sextantis,	6	99	48
30	14	40	Em.		310	260
31	11	40	*Im.* *u* Leonis,	6	160	116
31	12	39	Em.		267	232

METEOROLOGICAL OBSERVATIONS FOR NOVEMBER, 1843.

Moon.	Days.	Therm. Sun Rise.	Therm. 2 P.M.	Baromtr. Sun Rise.	Baromtr. 2 P.M.	Wind. Direction.	Wind. Force.	Water Fallen in rain	State of the Weather, and Remarks.	
	1	28°	47°	30.25	30.20	NE.SE	Moderate		Clear.	Clear.
	2	45	50	29.72	29.72	W.	Brisk	1.10	Rain precg. ngt.	Clear.
	3	35	43	29.93	29.92	W.	Moderate		Clear.	Clear.
	4	29	41	30.03	29.95	NW.	do		Clear.	Cloudy.
	5	29	35	30.05	30.04	NW.	Brisk		Cloudy.	Clear.
	6	26	40	30.09	30.04	W.	Moderate		Clear.	Clear.
☺	7	31	33	29.88	29.80	NE.	Calm	.11	Cloudy.	Snow.
	8	33	41	29.80	29.82	W.	Brisk		Par. cloudy.	Par. Cloudy.
	9	30	39	29.80	29.87	NW.	Moderate		Clear.	Cloudy
	10	40	50	29.75	29.70	NW.	Calm	.08	Rain.	Cloudy.
	11	43	52	29.31	29.26	E.NW.	Brisk	1.30	Rain.	Cloudy.
	12	36	41	29.86	29 95	W.	do		Snow.	Clear.
	13	29	37	29.97	29.85	W.	Moderate		Par. cloudy.	Par. cloudy.
☽	14	27	35	30.11	30 09	W.	do		Clear.	Clear.
	15	27	43	30.20	30.15	SW.	Calm		Cloudy.	Clear.
	16	41	46	30.00	29.97	E.	do	.43	Rain.	Cloudy.
	17	46	52	30.06	30.06	SE.	do	.14	Cloudy.	Rain.
	18	55	61	29.81	29.77	W	Moderate		Par. Cloudy.	Clear.
	19	38	50	29.98	29.97	W.	Brisk		Clear.	Par. cloudy.
	20	36	50	30.11	30.08	SW.	Calm		Clear—cloudy.	Rain.
⊗	21	44	44	29.61	29.53	E.	do	.73	Par. cloudy.	Rain.
	22	36	44	29.65	29.71	W.	Brisk		Clear.	Cloudy.
	23	30	49	29.88	29.85	W.	Moderate		Clear.	Clear.
	24	55	62	29.61	29.55	SW.	do	.06	Rain.	Par. cloudy.
	25	37	46	29.95	30.02	NW.	do		Clear	Clear.
	26	34	46	30.07	29.86	NW.	do		Clear.	Par. cloudy.
	27	29	32	29.94	29.97	NW.	Brisk		Rain—cloudy.	Clear.
☾	28	31	38	30.06	30.00	SW.	Calm		Clear.	Clear.
	29	32	33	29.80	29.66	E.	do	.12	Cloudy.	Rain.
	30	32	38	30.07	30.14	NE.	do		Cloudy.	Cloudy.
		35.47	43.9[illegible]	29.91	29.88			4.07		

Thermometer.		Barometer.	
Max. 62.00, on 24th. Min. 26.00, on 6th.	Mean, 39.70	Max. 30.25 on 1st. Min. 29.26 on 11th.	Mean 29.895

DECEMBER, 1843.

Moon.	Days.	Therm. Sun Rise.	Therm. 2 P.M.	Baromtr. Sun Rise.	Baromtr. 2 P.M.	Wind. Direction.	Wind. Force.	Water Fallen in rain	State of the Weather, and Remarks.	
	1	27°	34°	30.15	29.98	NE.	Calm	.21	Snow.	Snow.
	2	30	36	29.82	29.84	NE.	do		Cloudy.	Clear.
	3	30	34	29.95	30.00	N	do		Clear.	Clear.
	4	24	40	30.06	29.93	SW.	Moderate		Clear.	Cloudy.
	5	35	36	29.78	29.86	NW.	Blusteri'g		Par. cloudy.	Clear.
☺	6	19	30	29.70	30.03	N.SW.	Moderate		Clear.	Cloudy.
	7	28	31	29.68	29.56	SE.NW.	Calm	.65	Snow.	Snow.
	8	31	38	29 83	29.76	SW.	Moderate		Clear.	Clear.
	9	34	36	29.62	29.62	S.SW.	do		Cloudy.	Par. cloudy.
	10	24	32	29.92	30.03	SW.	do		Clear.	Clear.
	11	30	37	29 76	29.68	SW.S.	do	.02	Cloudy.	Rain.
	12	29	36	29.74	29.85	NW.	Brisk.		Clear.	Par. cloudy.
	13	14	22	30.44	30.50	NW.	Moderate		Clear.	Clear.
☽	14	15	33	30.48	30.42	SW.	do		Clear.	Clear.
	15	29	41	30.33	30.28	SW.	Calm		Par. cloudy.	Clear.
	16	35	42	30.16	30.00	E.	do		Misty.	Rain.
	17	36	40	29.84	29.83	N.	do	.42	Rain.	Cloudy.
	18	34	39	29.95	30 04	E.W.	Moderate		Cloudy.	Par. cloudy.
	19	33	40	30.15	30.13	W.	Calm		Cloudy.	Cloudy.
	20	32	44	29.95	29.92	NW.W.	Moderate		Clear.	Clear.
⊗	21	33	43	30.20	30.15	W.	Calm		Clear.	Cloudy.
	22	37	40	29.88	29.67	NE.	do		Cloudy.	Rain.
	23	36	36	29.82	29.88	E.	do	.86	Rain.	Cloudy.
	24	34	40	29.93	29.86	SW.	do		Cloudy.	Cloudy.
	25	34	42	29.95	29.95	SW.	do		Cloudy.	Cloudy.
	26	38	42	30.05	29.94	E.	do	1.30	Cloudy.	Rain.
	27	36	42	29.76	29.76	SW.W.	do	.26	Cloudy.	Clear.
☾	28	38	42	29.73	29.58	E.	do		Cloudy.	Rain.
	29	32	34	29.67	29.67	W.NW.	Brisk		Clear.	Clear.
	30	29	34	29.69	29.69	NW.	Blusteri'g		Clear.	Clear.
	31	30	36	29.73	29 68	N.	Brisk		Clear.	
		30.52	37.16	29.92	29.94			3.7[illegible]		

Thermometer.		Barometer.	
Maximum 44.00 on 20th. Minimum 14.00 on 13th.	Mean 33.84	Max. 30.50 on 13th. Min. 29.54 on 7th.	Mean, 29.93

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE

State of Pennsylvania

AND

AMERICAN REPERTORY.

MARCH, 1844.

Civil Engineering.

Major Parlby's Breakwater.

The Society of Arts have voted to Major Parlby, a silver medal, for a plan of forming breakwaters, of which the following description has been sent us:—

The principle of this breakwater is taken from what may be observed in every part of the world, viz., the effects of reeds in rivers and lakes, and of sea-weed in the ocean, in calming, or subduing, the turbulence of the swell of waves. Now, there is a fucus, or marine plant, common in the seas about the Cape of Good Hope, which grows in a long tubular form, from twenty to thirty feet in length; at one end—that which floats upon the surface of the sea—it has a trumpet formed termination, while the other attaches itself to rocks at the bottom of the sea. This has served as a kind of model to Major Parlby for the construction of the component parts of his breakwater, which is, indeed, merely planting a complete bank of artificial gigantic reeds in the middle of the sea. Major Parlby's first idea was the employment of a considerable number of spars, such as those used for scaffolding, enlarging one end, and adding cork to make them more buoyant, and attaching the other end by a piece of chain, or rope, to the bottom of the sea, by means of ballast, cast-iron framings, or other practical means, and placing these spars about three feet from each other from centre to centre, and from fifty to eighty in depth; but an intelligent gentleman having suggested the employment of India rubber, (a very happy idea,) Major Parlby purposes now to form the breakwater by pieces of the coir rope of India, which is itself exceedingly buoyant, and almost imperishable in salt water, and coat-

ing and forming the reeds, or floating trumpets, with India rubber, so as, in some degree, to resemble the very weed itself. A more happy, or a more practical plan of forming a breakwater can hardly be conceived, as they can be of every form, shape, and size, and have this peculiar advantage over all breakwaters that have yet been proposed, that they do not interfere with the sea way, but a vessel can sail through them, without injury, in every direction, and thus no particular entrance to a harbor is required, but vessels can enter whatever the wind and tide may be. The application of this breakwater, Major Parlby remarks, may be found of great service for the following purposes: For protecting roads for shipping, harbors, piers, landing places, &c. For forming harbors of refuge in the open sea for ships, coasters, and fishing boats, wherever it is desirable, where good anchoring ground can be found. For preserving the coasts of the sea, and thus much valuable property from annual dilapidation and loss, by the falling of cliffs, the washing away of land, and from the effects of the violence of the waves. For breaking and calming the sea on all the sloping sandy shores where bathing machines are in use, so as to prevent the dangerous and injurious effects of breakers on the shore.

Practical men, who will immediately begin to inquire into the cost of breakwaters of this description, may be guided in their estimate by the calculation of the number of floating reeds, or trumpets, required, placed at three feet apart, and fifty feet in breadth; a breakwater of extent equal to that at Plymouth, which is about 1700 yards, or nearly a mile, will require $1700 \times 50 = 85{,}000$; the cost of these will, of course, depend upon the depth of the sea, as the trumpets must be long enough to reach from the bottom to the top of the water at the highest tide; and, as far as calculations have at present been made, the expense of the coir and India rubber trumpets, with the cast-iron gratings and ballast to fix them securely at the bottom of the sea, may be about 2*l.* each trumpet—consequently, the expense of a breakwater on this principle, equal to that at Plymouth, would be 160,000*l.* —a very small sum compared with the expense of that magnificent work, which, however valuable as a protection to the harbor in severe gales of wind, has, in consequence of its unyielding materials, been the cause of the loss of several vessels; and as large open sea-ways are obliged to be left at each end of the breakwater, the swell and turbulence of the sea enters with great violence at times, rendering the passage in and out extremely dangerous. The breakwater, on Major Parlby's principle, may stretch completely across a channel from shore to shore, without offering much impediment to the sea way—and certainly no dangerous one. It is also capable of being removed at any time, without any considerable expense; a thing impossible to be done with stone breakwaters.

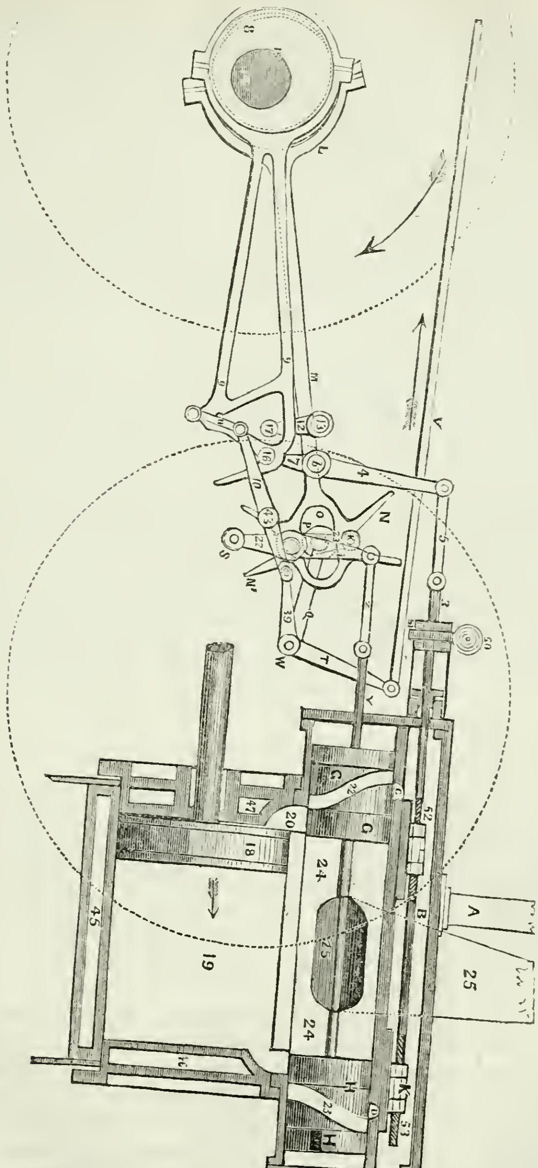
Lond. Mech. Mag.

Parsons' Locomotive Expansive Apparatus.

Fig. 1, represents a section of one of a pair of locomotive cylinders,

with its valve, and an elevation of the necessary gearing for working the steam and expansion valves. Fig. 2, is an elevation of the gear-

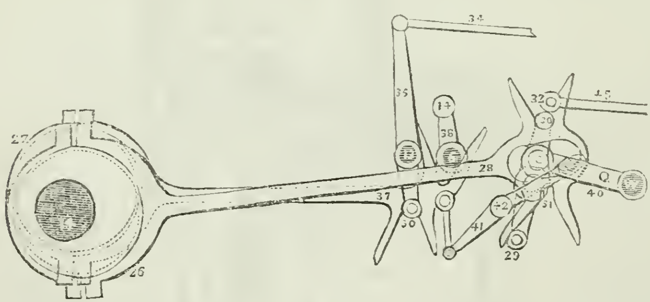
Fig. 1.



ing for working the valves of the second cylinder. The cylinders are provided, in the usual way, with pistons, piston-rods, and connecting

rods, for the purpose of communicating the power of the steam to two cranks at right angles to each other on the same shaft, or axle, to which the driving wheels of the engine are attached. The steam from the boiler enters through the pipe, A, into the valve-box, B, which box contains two flat sliding valves, I and K, attached to the same rod, 3, for the purpose of cutting off the communication between the boiler and the cylinder, so that the steam may act on the piston by its expansive force. The two valves, I and K, have nuts let into them, one with a right-handed, and the other a left-handed thread, into which the rod, 3, is screwed, so that when it is turned, by means of the endless screw, 50, and wheel, 51, the distance between the valves is either increased, or lessened, according to the degree of expansion required. At the end of the rod on which is fixed the endless screw, 50, a fine thead is cut, with a traveling index, which shows the precise amount of expansion. The rod, 3, is connected to the lever, 4, by means of another rod, 5, and the lever, 4, is attached to a shaft, 6, on which is fixed another lever, 7, which receives motion from the eccentric, 8, through the eccentric rod, 9 9. The eccentric rod, 9 9, can be made either to impart its motion to the lever, 7, as represented in the drawing, or by raising it by the lever, 10, and link, 11, to the lever, 12, which is fixed on the shaft, 13. The eccentric, 8, is fixed on the main crank-shaft of the engine in such a position that its centre, 15, may make an angle of 45° with a line drawn from the centre of either of the pins, 16 or 17, through the centre of the main shaft, 14, when the piston is at the top of its stroke. C to G, and H H, are two piston-valves, connected by the rod, X, having passages, 22 and 23, through which the steam passes from the openings, C and D, and alternately to each side of the piston, 18, and

Fig. 2.



thence through the openings, 20 and 21, into the eduction passage, 24, and blast pipe, 25, whence it finally escapes into the atmosphere, after having performed its duty in the cylinder. These valves are connected to the lever 1, by the rods Y Z, which lever is fixed on the weigh-shaft 2, to which are also fixed two levers, 22 and 23, which receive motion from the eccentric L, by means of the eccentric rod M, which terminates in two forks, N N[1], and a slot, O. The eccentric L, is fixed on the crank-shaft, 14, at an angle of 90°, with a line drawn from the centre of the crank-shaft 14, to the centre of the weigh-shaft 2, when the piston is at the top of its stroke. The

forks of N N^1, serve to guide the pins R and S, into their respective notches in the usual way, when the engine is reversed, or the contrary. A roller, P, is placed in the slot O, and turns freely on a pin at the end of the lever Q, which supports the weight of the eccentric rod M, and shifts it either on to the pin R, or the pin S, according to which way the engine is required to move. This lever, Q, is fixed on the lifting shaft W, which receives its motion from the lever T, connected by the rod U, to the reversing lever, which is under the control of the driver. The gear for working the valves of the second cylinder, represented in fig. 2, differs but little from the gear employed to work the other. The eccentrics 26 and 27, are placed in a similar position as the eccentrics 8 and L, before described, and the eccentric rod 28, is similar, in every respect, to the eccentric rod M, and communicates its motion to two levers, 29 and 30, on the weigh-shaft 31, to which the lever 32, is fixed, which gives motion to the slides, similar to G and H, fig. 1, through the rod 45, in the same way as before described.

The rod 3, which is fixed to slides similar to I K, in fig. 1, receives its motion from a lever, 35, fixed on the weigh-shaft 13, on which is another lever, 36, to which the eccentric 27, gives its motion through the rod 37. The eccentric rod 37, can also be made to impart its motion to the lever 38, on the shaft 6, by lifting it up, the fork 47, guiding the pin 44, into the notch provided for it. The levers, rods, &c., are shown in such a position as to make the cranks and shaft revolve in the direction shown by the arrows. But when it is required to reverse the motion of the engines, the rod U, is moved by means of the reversing lever V, in the direction indicated by the arrow, causing the lever T, to turn the shaft W, on its centre. The motion thus communicated to W, passes down the levers Q, 39 and 40. The lever Q, causes the rods M and 28, to move off the respective pins, R and 30, on to the pins S and 29, thereby reversing the steam-slides G and H, and similar ones in the other cylinder. At the same time the small levers 39 and 40, cause the levers 10 and 41, to move about their respective centres, 43 and 42, and thereby the eccentric rods 9 9, and 37, to move off the pins 16 and 36, on to the pins 17 and 44. It will be seen that by this arrangement the eccentric 8, will work the expansion-slides of the opposite engine, and *vice versa*, thereby reversing the expansive-slides of each cylinder. The valves I and K, may be made either in one piece, or two; but Mr. Parsons prefers making them in two, for the purpose of adjusting the expansion to any required degree. To keep the steam warm during its action in the cylinder, he uses a jacket, 45, and allows the steam from the boiler to have free access to the space between it and the cylinder, and likewise to the spaces 46 and 47, at the top and bottom of the cylinder. Mr. Parsons recommends that the whole of the jackets and steam spaces shall be well clothed with felt.

The description given in the specification of this arrangement, for working and reversing the expansive valves, concludes with a valuable suggestion: "It may be applied," says Mr. Parsons, "to work the ordinary valves of locomotive engines, when the lead of the

eccentrics amounts to an angle of 45°, whereby two of the four eccentrics, now generally employed, may be dispensed with."

The metallic packing for the pistons and valves is constructed in a novel and very ingenious manner: two split rings made of any two metals, such as wrought and cast-iron, which expand unequally under equal increments of temperature, are riveted, or otherwise firmly secured together, the most expansive metal being placed innermost. The splits in the two rings do not correspond, but are made at a short distance from each other, so that the inner ring shall extend behind a tongue, which is accurately fitted into the outside ring, by which means the steam is prevented from passing through the splits when the rings become heated by the steam. The inner one expanding more than the outer, they have a natural tendency to open, or buckle outwards, and press against the cylinder without the aid of springs; and this property they will retain until the outside ring is completely worn away. The pressure too must always be in proportion to the temperature, and, consequently, the pressure of the steam. In the valves, the outside ring is made to lap over the edges of the piston frames, which, consequently, do not interfere with the passages.

Ibid.

On working Locomotive Engines Expansively, and the applicability to the purpose of Parsons' Patent Expansive Apparatus. By Messrs. Parsons and Bunning, Civ. Engs.

Many attempts have been made to effect a saving of fuel in locomotives, by working the engines more expansively than is now the practice, but experience has seemingly proved that no advantages are gained by making the steam expand more than one-fourth of the stroke. Many engineers have attributed the failure to the rapid rate the engines travel at, which, they think, does not allow time for the steam to expand. But this reason cannot hold good; for when the steam is once admitted into the cylinder, cut off and confined there, were it not to expand, it must be at a greater pressure near the cover of the cylinder, than near the piston, which is manifestly absurd. Doubtless, however, there is a loss which a common unexpansive engine is liable to, from the great velocity of its piston: for when the crank is going over its centres, the piston has scarcely any motion, and the steam has time to pass through the openings, and attain a pressure nearly equal to that in the boiler. But the very great velocity of the piston, when at half-stroke, considerably reduces the pressure in the cylinder, which, however, is again increased as the piston loses its velocity, so that the whole cylinder, full of 50 lb. steam, is used, while an average pressure of perhaps from 40 to 45 lbs. only is rendered available. This is manifestly occasioned by the openings into the cylinder being too small to supply steam, when the piston is moving at its greatest velocity. But this loss will not attend an engine in which the steam is cut off before the piston has attained that

greatest velocity; for the steam, once in the cylinder, cannot be throttled, it is a mechanical impossibility that it should not expand.

The great drawback, however, to expansion with the common slides, is most probably the loss of power occasioned by closing the eduction opening too soon, and thereby compressing the steam that remains in the cylinder; for, suppose the steam is cut off at half stroke, admitted precisely as the piston is at one end of the stroke, and allowed to pass into the atmosphere at the moment it arrives at the other, then it is evident that the eduction port will be closed, and the communication with the atmosphere cut off at half-stroke. Now, although this does not seem a very great evil at first sight, as the steam is supposed to have been already got rid of, yet it is a source of a most serious loss of power. For the back pressure on a locomotive, owing to the diminished size of the blast-pipe, is certainly not less than 5 lbs. per inch, and the pressure of the atmosphere being 15 lbs., makes a total pressure resisting the force of the steam equal to 20 lbs. per inch, at the time the communication with the atmosphere is shut off. Let us suppose, therefore, that the cylinder has a 20-inch stroke; the back pressure being, as we have shown, 20 lbs., when the piston has traveled 10 inches, and, consequently, when it has moved another 5 in. the pressure will be increased to 10 in. of 20 lb. steam, compressed into 5 in., which would be equal to 40 lbs.; and at the end of the stroke it will equal 5 in. of 40 lbs. steam, compressed into the clearance, say half an inch, or not less than 400 lbs. upon the inch; but when the total pressure of this steam on the face of the valve which covers the opening, exceeds that on the back, it lifts the valve, and allows the steam from the boiler a free communication with the atmosphere. This, then, is the reason of the non-success of expansion, when carried to any considerable extent with the common valve, and not, as supposed by some, because the steam has not sufficient time to expand.

It is usual with the best engine makers to allow the steam to pass into the atmosphere, a little before the piston has arrived at the end of its stroke, and it is undoubtedly advantageous to do so, as by that means the eduction port is well opened by the time the piston begins to return; but if this is carried too far, there is a loss of power, as the steam is thrown away before it has given out the whole of its force.

Expansion with the common slide, (to be attended with beneficial results,) is, therefore, limited; for if carried beyond a certain extent, the loss, from throwing away the steam before the piston has arrived at the end of its stroke, and from compressing it in the cylinder more than counterbalances the benefits derived from the increased expansion. It, therefore, becomes a nice point to settle how to obtain the greatest quantity of expansion without diminishing the power of the engine. Experience and the practice of the most celebrated makers have proved, that the best and most economical point at which to cut off the steam with the common slide, is at about three-fourths of the stroke of the piston. If carried beyond this, the evils above enumerated, begin to manifest themselves; but in our patent engines, with our patent apparatus, the steam may be cut off *at any part of the*

stroke at the pleasure of the driver; it may be altered too while running, and it is admitted, or cut off, when the piston has scarce any velocity, while the eduction steam has a free communication with the atmosphere during the whole of the stroke.

The following table shows the relative consumption of steam of two engines of equal power, one on the most approved common construction, cutting off at 14 inches, and one on our patent principle, cutting off at 4 inches of the stroke of the piston.

TABLE.

	Cylinders.		Length of stroke in inches.	Distance the piston has traveled when the steam is cut off, in inches.	Press're of the steam in the boiler in lbs. per square inch.	Mean press're on the piston in lbs. per square inch.	Total mean pressure on the piston in pounds.	Quantity of steam used at a single stroke in cubic inches.
	Diameter in inches.	Area in square inches.						
Common engine,	12	113	18	14	55	52.7	5955.	1582
Patent engine,	$17\frac{7}{8}$	249.5	18	4	55	23.87	5955.5	998

It will thus be seen that our patent engine, when cutting off at 4 inches, as in the table, will be fully equal in power to an ordinary 12 inch engine; but its power can be increased to a very great extent, by admitting a greater charge of steam. It can also be lessened to suit the load and the gradients. It will be further observable, that the quantities of steam used are in the proportion of 1582 to 998; or taking the quantity used by the common engine as 100, that used by the patent engine will be 63, which is equal to a saving of 37 per cent. from expansion alone. Besides, the pressure on the piston of the common engine is here taken, as if it were of the same pressure as that in the boiler until cut off; but, for the reasons before stated, this is unlikely to be the case.

As the table exhibits so great a saving in steam, it would be natural to suppose that much smaller boilers would be sufficient to produce it; but we would recommend that boilers of the ordinary size, or nearly so, in proportion to the power of the engine, should be employed, and that the blast-pipe should be considerably increased in size, thereby diminishing the force of the blast, the back pressure, and the rapidity of combustion.

The advantages which we expect to result from the adoption of our expansive apparatus are these:—

1st. A great saving in fuel and water, arising from three causes; first, from using the steam expansively, to the extent, and in the manner proposed, as shown in the table; 2nd, from the slower combustion; and 3rd, from the diminished back pressure.

2nd. The increased durability of the fire-box and tubes, consequent on the slower combustion, and diminished blast.

3rd. The ability to increase, or diminish, the power of the engine,

without stopping to adapt it to the different gradients, and to the different weights to be drawn.

4th. Having at command more than double the power of the engine when suddenly reversing to prevent a collision, on account of the increased area of the cylinders.

5th. The number of engines on a railway may be considerably lessened; and it will not be necessary to have engines constantly in attendance at the foot of steep inclines, to assist the trains.

6th. The number of water cranes and stationary pumping engines may be considerably diminished, as the same quantity of water will supply an engine for double the distance.

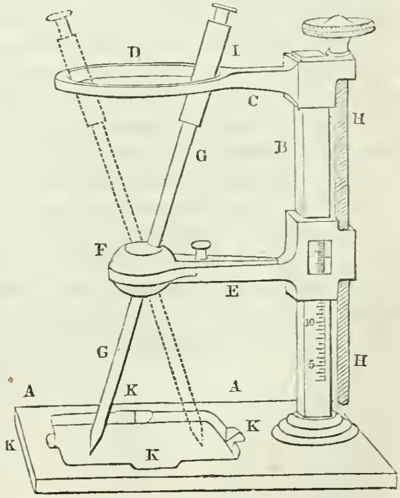
7th. The danger of setting fire to property adjoining the line, from red hot ashes, driven out of the chimney by the blast, will be done away with, as the power of the blast will be considerably reduced.

We hope that the above remarks will serve to show that steam cannot be used expansively, to any great extent, with the common valve; but, that, by means of our patent gear, the expansive system may be carried out to a very great extent, in locomotive engines, and the cost of working railways be proportionally reduced.

Ibid.

Elliptograph, a new Drawing Instrument, by John Hick, Jr., *of Bolton, Lancashire.*

The annexed figure represents the Elliptograph, a model of which is in the Society's Repository, since depositing which, however, Mr. Hick has substituted a universal joint, or centre, for the ball and socket joint, F, shown in the figure, and when drawing in isometrical perspective, he removes the flat part, I, allowing the pencil, or pen-holder, itself to be in contact with the inner rim of the elliptic gauge, D. On the base plate, A, is fixed an upright bar, or standard, B, to the top of which is attached the projecting arm, C, carrying an elliptic ring, D, below which, on the same standard, is another projecting arm, E, provided at the end with a ball and socket joint, F, which forms the centre of motion for the pencil, or pen-holder, G, passed through it. The arm, E, can be raised, or lowered, at pleasure, by means of the screw, H.



By passing the upper end of the pencil-holder round the inside, and in contact with the gauge ellipse, the point will describe on the

paper laid beneath the stand, A A, an ellipse of the same proportions as the gauge above, and of other required sizes, by raising, or lowering, the arm, E.

The holder has a flattened part at I, which, in moving round, must always be kept against the edge of the gauge, in order to preserve the pen in its right position for drawing.

In the instrument, as shown in the figure, only one proportion of ellipse can be described; but as it is that generally required, (and entirely so for isometrical drawing,) but little alteration is required to make it generally useful.

A few gauge ellipses of various proportions may easily be substituted for that at present attached to the instrument.

The standard, B, is graduated on two sides, so as to describe on paper an ellipse of relative transverse and conjugate diameters, one side corresponding with the major, and the other with the minor axis of the ellipse, and by means of the centre lines, K K K K, the instrument may be accurately set in the required proportion on the paper.

Trans. Soc. Arts, Manuf. & Com.

Manumotive Railway Carriage.

We are informed that a machine of this description is in use upon the London and Croydon Railway, having been lately made for Mr. Gregory, the resident engineer, by Mr. George England, engineer, well known as the inventor of the patent traversing screw jack, and other important improvements. The machine is light and elegant in appearance, and will carry seven or eight persons at the rate of eighteen miles an hour. It was propelled on Monday last by Mr. Roberts, deputy chairman of the Croydon Company, and Mr. England, the inventor, from the New Cross station to the Dartmouth Arms—a distance of three miles up an incline of 1 in 100, in seventeen minutes, and upon the level line at the rate of twenty miles an hour. It is intended to be used by Mr. Gregory, and his assistants, to traverse the line, inspecting any repairs, or other works, going on connected with the railway; and will, in our opinion, be found particularly useful for this purpose, and more especially so in connexion, with those works upon the line which it is necessary to carry on during the night. We have no doubt that these machines will come into general use, as they will effect a considerable saving to the company, in the expense of running an engine for the purposes which they will supply. We hail with pleasure anything calculated to reduce that most important item in railway accounts—the locomotive expenses.

Lond. Railway Times.

Royal Steam Navy—Parliamentary Returns of Cost of Engines, Makers' Names, Expenditures for Repairs, &c.

A Return of the original Cost of the Engines of the following Steam Vessels, specifying any extra charge beyond Contract price, and if such vessels were fitted with an Indicator; of Repairs, and of the cost of such repairs, and the number of days and hours any of said vessels were incapable of performing their work, in consequence of such repairs; and of the names of the makers of each of the engines of said vessels:

Names of Vessels.	Original Cost of Engines.	Extra Charge beyond Contract price.	Indicator.	Repairs. Nature.	Repairs. Period over which they extend. From	To	Cost of Repairs.			No. of days and hours the vessels were incapable of perform'g their work, in consequence of such repairs.	Names of the Makers of the Engines.
	£	£					£	s.	d.		
Alecto,	10,700	297	not fitted.	two engines boilers and paddle-wheels.	13 Jan. 1840	31 Mar 1843	1,158	4	$4\frac{3}{4}$	393	Messrs. Seaward & Capel.
Devastation,	18,650	681	do.	do.	Dec. 1841	do.	249	10	$8\frac{1}{4}$	92	Messrs. Maudslay, Son & Field.
Geyser,	13,933	440	do.	do.	July 1842	do.	89	7	$3\frac{1}{2}$	50	" Seaward & Capel.
Cyclops,	22,103	906	do.	do.	Oct. 1840	do.	800	7	10	164	do. do.
Prometheus,	10,700	315	do.	do.	March 1840	do.	1,012	1	$5\frac{1}{2}$	353	do. do.
Polyphemus,	10,700	214	do.	do.	June 1841	do.	240	7	$11\frac{1}{4}$	162	do. do.
Vesuvius,	13,480	400	do.	do.	Oct. 1840	do.	37	19	$0\frac{1}{4}$	38	Mr. Robert Napier.
Stromboli,	13,480	nil.	do.	do.	Sept. 1840	do.	63	6	$3\frac{1}{4}$	51	do.

WILLIAM EDWARD PARRY,
Comptroller of Steam Machinery.

Admiralty, 26th May, 1843.

Mechanics, Physics, and Chemistry.

ENGLISH PATENTS.

Specification of a Patent granted to Samuel Kirk, *of the county of Lancaster, for certain improvements in Machinery, or Apparatus, for preparing cotton and other fibrous substances for spinning. Sealed* 31*st January*, 1843.

These improvements in machinery, or apparatus, for preparing cotton, and other fibrous substances, for spinning, consist in a novel arrangement and combination of mechanism, for the purpose of compressing the sliver, or web, of cotton, (as produced by the carding engine, and other preparation machinery,) or other fibrous substance, into cans, or suitable receptacles, in order to form the same into coils, containing a much greater quantity, or weight, of cotton, or other fibrous substances than hitherto produced, and, consequently, lessen the number of piecings, producing thereby a more even sliver, and also to lessen the amount of labor usually employed in the preparation processes.

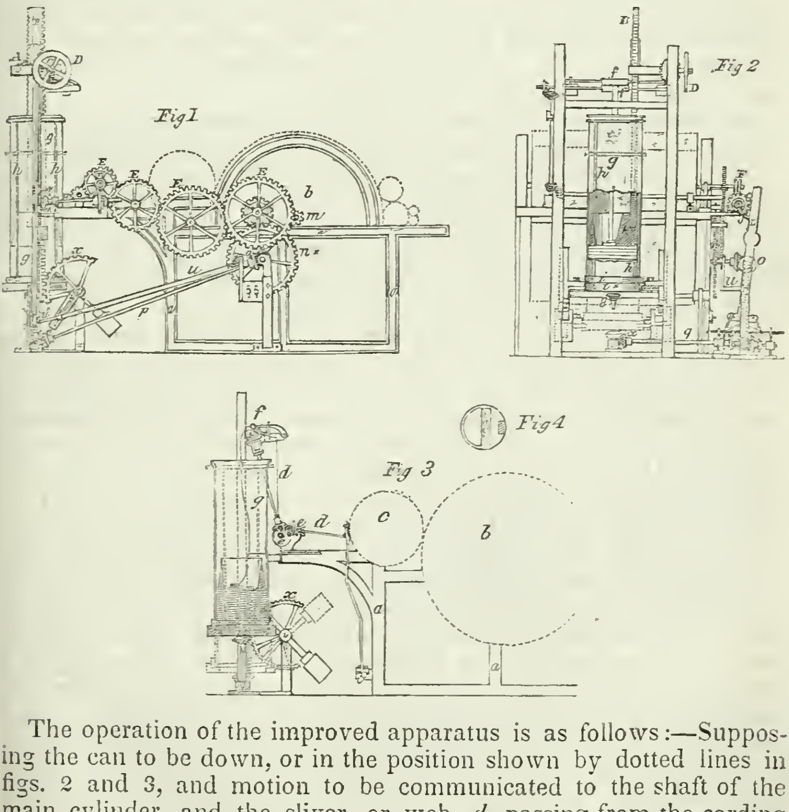
The practical spinner, will, doubtless, be aware that the sliver, or web, of cotton has, in some manufactories, been hitherto slightly pressed into the common small cans, and on, or into, other receptacles now ordinarily used to receive the web as it is produced by the carding engine, either occasionally by the hand of the attendant, or by a mechanical contrivance.

The object of the present invention is to effect this operation in a greatly extended degree; to employ cans, or other receptacles, of increased diameter, or size; and to compress the web, or sliver, into a firm and compact body, or to form a continuous coil, as hard as the fibres will allow, and, consequently, effect a great economy in the number of cans, or other receptacles, as also in the bobbins, commonly used; as these said coils of slivers, or webs, may be doubled in any degree, or number, and similarly pressed, in connexion with the drawing, slubbing, and roving machines, and so afterwards be taken direct to the spinning frames, entirely without the use of bobbins, if so preferred.

The drawings represent the improved combination of mechanism, as applied to an ordinary carding engine for carding cotton; and as the further application to the various operations, during the preparation process, will be evident to the practical spinner, a description of them, with reference to the drawing, slubbing, and roving machines, is considered unnecessary.

Fig. 1, represents, in side elevation, the improved pressing apparatus, as attached to the delivering, or doffing, end of the carding engine; fig. 2, is a front, or end elevation, shown partly in section; and fig. 3, a longitudinal section, taken vertically through the same. The frame of the carding engine is represented at *a, a;* the main cylinder at *b, b;* and the doffing cylinder at *c;* the web, or sliver, of cotton is shown at *d, d,* as proceeding through the drawing rollers, *e, e,* and

being conducted upwards through a pair of delivering rollers, *f, f*, from whence it passed into the can, or receptacle, *g, g*. This can is merely a tube, of about 12 or 14 inches in diameter, and about 4 feet long, open at both ends, and placed within a slight frame of upright rods, *h, h*, connected with the bottom, or bed plates, *i, i*, upon which it stands. The can, or receptacle, is caused to revolve slowly, as hereafter described, in order to coil the sliver, or web, therein; and after moving a certain portion of a revolution, it is made to ascend, and thus compress the sliver, or web, which has been collected into the can, between the bottom plate and a presser, or block, *k, k*, which is suspended in the can; and, as it meets the descending sliver, the danger of stretching the sliver, which, in the present plans, frequently happens, is thereby obviated. This presser, or block, *k*, is formed with an opening, *l*, fig. 4, through which the sliver, or web, *d, d*, passes downwards into the can.



The operation of the improved apparatus is as follows:—Supposing the can to be down, or in the position shown by dotted lines in figs. 2 and 3, and motion to be communicated to the shaft of the main cylinder, and the sliver, or web, *d*, passing from the carding engine, between the small delivering rollers, *f, f*, and through the slot, *l*, in the block *k*, into the can, or receptacle *g*, the pinion *m*, on the cylinder shaft, giving motion to the spur wheels *n, n**, the bevel

wheels *o, o,* and diagonal shaft *p,* will, by means of the mitre wheel *r,* on the cross-shaft *q,* being in gear with the other mitre wheel *s,* attached to the plate *i**, under the bottom plate *i,* (see fig. 3,) cause the can to revolve slowly, and bring that portion of the sliver *d,* which has just been delivered into the can, immediately beneath the solid part of the block *k.* A crank-pin, *t,* is fixed to the spur-wheel *n**, and is connected to the lever *u;* the other end of which lever will, at every revolution of the wheel *n**, strike the pin *v,* on the short lever *w,* and push it into the position shown in the drawing; and, by means of the segment-wheel *x,* on the shaft *y,* raise the rack *z,* and with it the bottom plates, supporting the can *g;* thus the can will be lifted into the position shown in the drawing, and the cotton, or other fibrous material, be closely compressed between the bottom plate *i,* and the pressing block *k.* The wheel *n**, still continuing to revolve, will then, by withdrawing the lever *u,* from the pin *v,* allow the can to descend by its own gravity, and the tail *u**, of the lever *u,* sliding along upon the pin *v,* it will thus be out of action, and allow the can again to revolve, by the mitre-wheel *s,* falling into gear with the mitre-wheel *r;* the can will thus again commence revolving, and the operation proceed as before described.

As the cotton, or other fibrous substance, accumulates in the can, and raises the block higher, the small ratchet A, fig. 1, falls into the notches in one side of the upright rack B, which supports the block *k,* remaining in the same notch until the accumulation requires another, and prevents the block from falling when the can descends; the small pinion C, which takes into the teeth on the other side of the rack B, being merely for the purpose of raising, or lowering, the block by hand, when necessary, by turning the hand-wheel D. As the revolution of the can imparts a slight degree of twist to the sliver, and as this is not in all instances desirable, a common reversing motion is represented in the drawing, which may be applied to the apparatus, and by causing the can to revolve alternately, in different directions, (say three times in one direction, and three in the reverse,) it keeps the sliver even and untwisted throughout. In order to drive this reversing motion, a train of spur-wheels, E, E, E, actuate the worm F, working into a worm-wheel, G, on the short shaft H; on the other end of this shaft, H, is a catch, I, which, acting alternately against one of the pins K, K, on the upper end of the lever L, will cause that lever to oscillate on its centre, and throw the mitre-wheels M, and N, alternately into gear with the wheel O, on the lower end of the diagonal shaft *p.* When the can, or receptacle, has become filled with the compressed sliver, or web, it may be lifted up and entirely withdrawn, leaving the coil of cotton on the bottom plate, and supported by the rods, or framing, *h, h,* which may thus be removed from the machine. Instead of using the rods *h, h,* outside the can, an upright spindle, connected to the bottom plate, may be placed inside the can, and the coil of cotton built around it, which will sufficiently support the coil when the outer can, or casting, is removed. It will be perfectly evident to the practical spinner, that a similar application of the improvement, as above described, in connexion with the carding engine, may

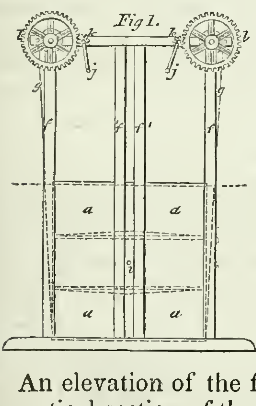
also be employed with the other machinery used for preparing cotton, or other fibrous material, for spinning, namely, the drawing, slubbing, and roving machines, in those instances where it is preferred to have the slivers of cotton, &c., made into coils, as first described, instead of being wound on to bobbins, as heretofore commonly practiced.

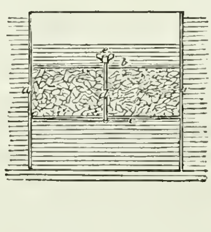
The patentee claims the peculiar combination, arrangement, and application of the machinery, or apparatus, above described, and exhibited in the drawings, to be used in connexion with the ordinary machines for preparing cotton, and other fibrous substances, for spinning, without confining himself to the present dimensions of apparatus for accomplishing, or effecting, the object above particularly described and set forth; that is, compressing the sliver, or web, into cans, or other receptacles, of a much larger diameter and length than commonly used, commencing the operation on the sliver at the bottom of the can, or receptacle, and proceeding upwards progressively, by self-acting means throughout.—[Enrolled in the Rolls Chapel Office, July, 1843.)

Lond. Journ. Arts & Sciences.

Specification of a Patent granted to William Henry Stuckey, *of Guildford street, for certain improvements in Filtering Water and other Fluids. Sealed 3rd December,* 1842.

These improvements in filtering water and other fluids, are described as consisting in the employment of compressed sponge, as a filtering material, and in a method of cleansing the said compressed sponge.





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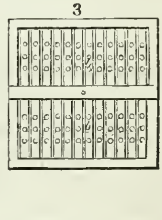


An elevation of the filtering apparatus is represented in fig. 1, and a vertical section of the case, containing the filtering material, at fig. 2. The sponge is held in a compressed state in the case *a*, between the two plates *b*, *c*; these plates have a number of openings formed in them, as shown in fig. 3, which is a plan view of the plate *b*, and are connected together by the bolt *d*, and nut *e*. The case *a*, is suspended in a frame, *f*, by bands, *g*, *g*, which are wound upon the barrels *h*, *h*,

when it is required to be raised; and the case is guided, in its ascent and descent, by a pin, *i*, projecting from each side of it, and working between the upright rails f^1, f^1, of the frame. By turning the handles *j*, *j*, motion is communicated to the barrels *h*, *h*, through the pinions *k*, *k*, and wheels *l*, *l*; and the barrels are held in any required position by a ratchet-wheel and click, at the end of each.

When in operation, the filtering apparatus is placed in the water, or other fluid, to be filtered, and the case *a*, is lowered into it to the depth shown in fig. 2; the water will, consequently, ascend through the compressed sponge, until it arrives at the same level as the water outside of the case, and, by so doing, will be deprived of its impurities; it is then drawn off by a syphon, or any other suitable contrivance. If the water be of a very foul, or putrescent, description, a layer of charcoal may be placed between the pieces of sponge.

When the sponge requires cleansing, the case *a* is raised out of the water, by means of the bands *g*, *g*, and the clear water, which has collected above the sponge, rushes down through it, and carries off the greater portion of the impurities. Then, if the bottom of the sponge be not sufficiently cleansed, it is allowed to expand, in a slight degree, by raising the nut *e*; after which the case is turned upside down, by means of the bands *g*, *g*, and lowered into the water, to the depth shown in fig. 2; when the water, rushing up from below, through the sponge, will carry to the top most of the remaining impurities. The case *a*, being now turned over into its original position, the foul water, which has collected at the top, is poured into the cistern, or reservoir; the supply of water is then shut off, and the cistern is emptied of its contents, or the impurities are allowed to settle.

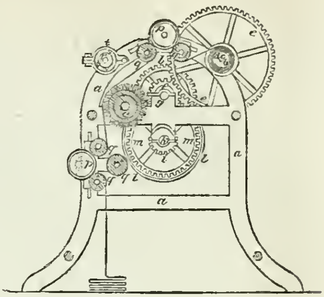
The claims made by the patentee, are, firstly, the employment of compressed sponge as the filtering material; and secondly, the means provided, as aforesaid, for cleansing the sponge, from time to time, without removing it from the machine.—[Enrolled in the Enrolment Office, June, 1843.] Ibid.

Specification of a Patent granted to Thomas Mitchell, *of Dalton, in the county of York, for a certain Machine and Apparatus for increasing and permanently fastening the face, or gloss, of all kinds of woolen, worsted, and fancy cloths, by the application of steam alone, without immersing the goods in water. Sealed June 15th,* 1843.

My invention relates, first, to a certain machine for winding woolen and worsted cloths, or fabrics, requiring heat in the finishing processes for laying the nap, or face, and obtaining a gloss, or finish, thereto; and secondly, to apparatus for applying steam to woolen and worsted cloths when rolled, in order more effectually and readily to set the face, and obtain a gloss thereto. And in order that my invention may be most fully understood, and readily carried into effect, I will proceed to describe the drawings hereunto annexed.

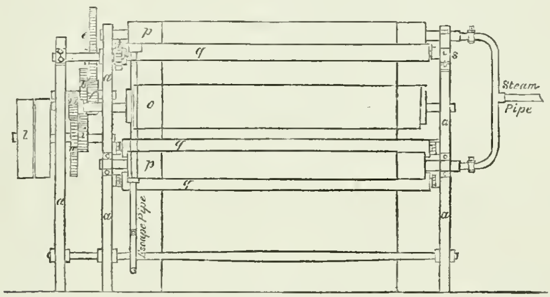
Fig. 1, shows a side view in section of a machine for rolling cloths of wool, or worsted; and Fig. 2, is a front view thereof.

Fig. 1.



This machine is so arranged that the cloth, in its progress to be wound on a roller suitable for having heat applied thereto to set the face, or gloss, thereof, passes against one or two heated rollers. *a, a,* is the framing of the machine; *b,* is the hollow roller, on to which the cloth is wound, at the two ends of which there are square holes, and a square bar, *c,* is passed through the cylinder, one end of which passes into the square socket, *d,* and the other end of the bar has a cylindrical neck which moves in a bearing at the other

Fig. 2.

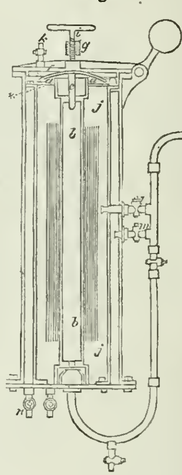


side, passing on the socket, *d,* which turns in a suitable bearing, on which is affixed the cog-wheel, *e,* which receives motion from the cog-wheel, *f,* affixed on the axis, *g.* On the axis, *g,* is a cog-wheel, *h,* which is driven by the cog-wheel, *i,* affixed on the main axis, *k,* which main axis is driven by a shaft acting on the pulley, *l.* On the main axis, *k,* is affixed the cog-wheel, *m,* which takes into and drives the cog-wheel, *n,* on the axis of the brush cylinder, *o,* by which the nap of the cloth is laid, in its progress, to the roller, *b.* The cloth, in its passage to the roller, *b,* is subjected to the action of one or two steam, or heated, cylinders, *p, p,* over and against which the guide rollers, *q, q,* guide the cloth, as is indicated by the red line; and in case the cloth is to be heated, or smoothed, by only one heated cylinder, then, in place of the cloth passing against the lower heating roller, *p,* it is caused to pass over the third guide roller, q^1. In some cases it is required that the cloth should be wound off the roller, *b,* on to a similar roller, so as to cause the winding to be more tightly performed; in this case the cloth on the roller, *b,* is, by its square axis, introduced into the socket, *r,* the other cylindrical end of the bar being received by the bearing, *s,* when, another roller being placed at *b,* the cloth is re-wound, the other end first, and the degree of tightness of the winding is governed by the friction band, *t,* acting on the cylindrical collar, *v,* affixed in the socket, *r.*

I will now describe the second part of my invention, which relates to apparatus for applying steam to woolen and worsted fabrics when rolled. It has heretofore been common to apply hot water, and, in some cases, steam, to cloths, or fabrics, of wool, or worsted. Now, the object of this part of my invention is so to arrange apparatus, that steam may be applied, under pressure, to rolls of cloth enclosed in a suitable vessel, or apparatus, such apparatus being so formed as to allow of the atmospheric air being driven out thereof by the pressure of the steam, the peculiar feature of the invention being the use of steam above the atmospheric pressure, so that the vessel, or apparatus, may be rendered void of air by steam.

Fig. 3, is an external view. This apparatus is suitable for applying steam to woolen, or other, fabrics, whether the fabrics be introduced in the dry, or wet, state, in place of immersing such cloths in hot water, as heretofore practiced, and the rollers being hollow, allow the steam to be introduced into the interior of the roller. *b*, is the roller; at the upper end of the roller is a plug, which is withdrawn when the steam is first introduced into the interior of the roller; and when the air is driven therefrom, the plug, *e*, is introduced, and the cover, *f*, is closed, and the bar, *g*, passes under the catch, *h*, and then the screw, *i*, is screwed down on to the cover so as to cause the vessel to be closed air and steam tight; steam is then allowed to flow into the vessel, *j*, and thus drive off the air at the cock, *k*, which cock is then to be closed; and if the fabric has been introduced in the wet state, then I do not allow the steam to continue to flow into the vessel, *j*, after the air has been driven out, but close that cock, *l*, and open the cock, *m*, so that the external part of the apparatus will be kept full of steam, the air being first driven out by the steam at the cock, *n*, and in this state I retain the apparatus for from ten minutes to a quarter of an hour, the nature of the fabrics treated requiring a slight difference of time, which a little practice will enable a workman to judge of. If the roll of fabric has been introduced in a dry state, then I continue the supply of steam to the inner vessel during the same time, the outer vessel not then being required. The steam which I usually employ is of about 20 lbs. pressure on the square inch in the steam boiler, but I do not confine myself thereto so long as the steam passed into the closed apparatus offers a pressure to drive off the air therefrom, and render it void thereof. When worsted fabrics are being operated on, I can use the roller, or cylinder, *b*, as shown, or the same may be perforated all over with numerous small holes, as is now sometimes practiced with worsted fabrics, and which, when separately considered, forms no part of my invention. [Enrolled August 15th, 1843.

Fig. 3.



Ibid.

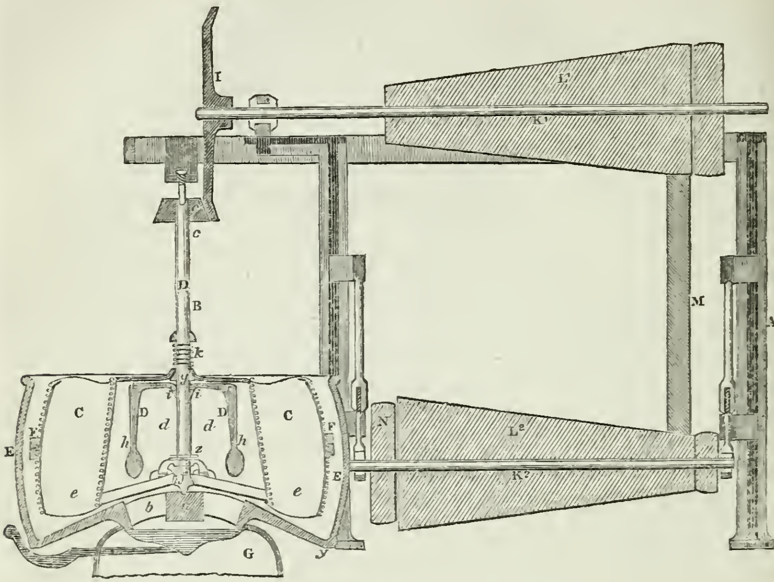
Specification of a Patent granted to Messrs. Keely *and* Alliott, *for a Drying Machine. Patent dated March* 2, 1843 *; Specification enrolled September* 2, 1843.

The idea of drying soft goods by causing them to revolve rapidly, and imparting thereby a strong centrifugal tendency to the liquid particles contained therein, is not new—for there have been two or three machines for the purpose before the present; but hitherto it has been followed out with only very partial success, owing to the difficulty of so constructing a machine, that the parts of it shall hold together at the high velocities necessary for drying goods rapidly. In one instance, where a machine of this sort was pushed to a speed of not more than about 300 turns a minute, a plate belonging to it flew off at a tangent, and cut the head of the attendant clean off. In the apparatus we have now to describe, this difficulty has, by a very happy combination of contrivances, been at length completely mastered. It is stated to be able to revolve with perfect safety at the rate of from 1500 to 2000 revolutions per minute, and such is the construction of the machine, that we see no reason to doubt the correctness of the statement. The inventor is a Prussian gentleman, of the name of Seyrig, from whom the English patentees, Messrs. Keely and Alliott, derive their title. From the specification of the latter, we extract the following description:—

Figure 1, is an elevation partly in section of this machine; A A, is the frame work; B, a vertical shaft which turns in a socket, *a*, in the bottom bridge, *b*, and carries at top a friction cone, *c*, by which a rotary motion is given to it in a manner afterwards explained. C, is a drum of two concentric compartments, *d*, *e*, of the shape shown in the engraving, which is fitted loosely on the shaft, B, and rests, when not in motion, on two conical projections, *f*, *s*, turned on the shaft. Both compartments have one common bottom of metal, and are formed at the sides, each of a continuous length of tinned iron wire, wound in a series of circles at small distances apart, and connected transversely by slips of metal soldered thereto. The top, or cover, of the inner compartment, *d*, is secured by nuts and screws to a ring of angle iron, which binds the wire sides together at the top; but that of the outer compartment, *e*, in which alone the goods to be dried are placed, is made to lift off in order to introduce and remove the goods, and has a rim both on its outer end and inner periphery, so that when fixed in its place, the inner rim presses against the outside of the inner compartment, and the outer rim overlaps the sides of the outer compartment itself. When the machine is at work, the cover of the outer compartment is further secured in its place by bolts, or pins, (not seen in the engraving.) The sides of the inner compartment, *d*, are connected to the bottom by prolonging the transverse slips of metal which connect the circles of wire, and riveting, and soldering them to the plates. The wire sides of the outer compartment are bound together at top by a ring of angle iron, to which they are riveted and soldered, and are connected to the bottom plate by turning

up the plate over the sides, and soldering and riveting as before. D, is a governor suspended within the inner compartment, *d*, of the drum, C; the two weighted arms, *h*, *h*, being loosely affixed at their elbows

Fig. 1.



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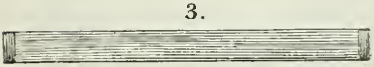
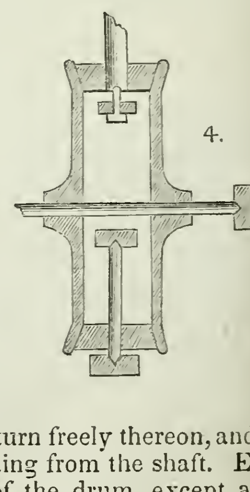




4.

to studs in the top plate of the drum, so as to turn freely thereon, and resting by their upper ends on a ruff, *i*, projecting from the shaft. E, is an outer case which surrounds the whole of the drum, except at the top, and is intended for the reception of the water driven off from

the goods, but is fixed, not to the drum, but to the frame work, A A. At *y*, there is a tap for drawing off the water, and in the bottom an orifice for the insertion of a pipe to admit hot air. When a rotary motion is given to the vertical shaft B, it carries round with it the drum, and in proportion to the velocity of the motion, there is a centrifugal tendency imparted to the liquid particles contained in the goods, which is the useful effect desired to be produced by the machine; but as the same centrifugal tendency in the parts of the machine, would, in case of any unequal distribution of the weight, cause, if not counteracted, an injurious strain on the central shaft, B, and might cause at the high velocities necessary for drying goods quickly, an actual disruption of the machine, and as this difficulty is increased when the weight of the goods happens not to be quite equally distributed over the drum, the governor, D, has been introduced, in order to prevent such consequences. For, as the speed of the shaft increases, the arms of the governor expand, and gradually raise the drum C, from off its seat on the conical supports, *f*, *g*, and thus leave the drum free to adjust itself, according to its natural gravitating tendencies, so as to bring the centre of gravity in uniform coincidence with the centre of rotation. The drum is gimbled to the shaft in the manner shown in fig. 1, and allows of the drum moving in any direction. To prevent the drum from rising too suddenly, there is a spiral spring, *k*, affixed to the shaft immediately above the conical support, *g*. For still farther maintaining the drum in a state of equilibrium, it is encircled at the middle by a hollow ring, or girdle, F, of which a plan and section are given separately in figs. 2 and 3, which is about half filled with water, or other suitable fluid. As this ring rotates, should the goods weight incline to preponderate at any part, the weight of water getting to the opposite side serves, more, or less, to prevent and counteract such preponderance. The equilibrating effect of this ring is increased, if the interior is divided into two, or more, channels. G, is a pipe by which steam, or hot air, can be introduced into the centre of the drum, when it is desired, by these means, to accelerate the drying of the goods; the bottom of the drum being perforated at the centre with a number of holes to admit the same.

The rotary action of the shaft, B, is obtained in manner following: I, is a disk affixed to the end of a shaft, which disk is beveled off near to its periphery, to correspond at that part with the surface of the cone, *c*, at the top of the shaft, B, so that when made to revolve in a horizontal direction, it shall cause the cone, *c*, and shaft, B, to revolve in a vertical direction; L^1 is a cone affixed to the end of the shaft, K^1, and L^2, another cone of the same dimensions, but placed with its base opposite the apex of the other, which is affixed to a shaft, K^2, communicating immediately with the first mover, which may be either a steam engine, water-mill, or any other suitable machine. M, is the belt which connects the two cones, and by the unwinding of which from the larger end of one cone, upon the smaller end of the other, or *vice versa*, with the help of a guide in the known manner of working such alternate cones, motion is communicated to the shaft,

K^1, and retarded, or accelerated, or kept at one constant rate, according as may be desired. N, is the pulley to which the power of the engine is directly applied. Instead of one friction disk only (I) being made use of, two such disks may be employed if found needful, as shown in fig. 5, and having an additional friction cone at the top, the better to equalize the action of the rubbing parts; but in that case the additional disk and cone must turn loosely in their bearings.

At the Lenton Works, near Nottingham, Messrs. Keely and Alliott have a machine of this sort in operation, the drum of which is 36 inches in diameter, and which is worked usually at the rate of from 1500 to 1600 revolutions per minute. A machine of the same magnitude, on any other plan—that of Robinson, for example, patented three or four years ago—could not be worked with safety at half that speed. Besides this, Robinson's machine is so made that one of 36 inches diameter could not hold more than half the quantity of goods, which can be conveniently stowed away in one on the present improved system of construction.

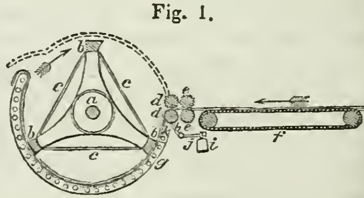
Lond. Mech. Mag.

Specification of a Patent granted to George Hickes, *of Huddersfield, in the county of York, for an Improved Machine for cleansing, or freeing, wool and other fibrous materials, of burs and other extraneous substances. Sealed* 21*st August,* 1841.

This improved cleaning machine contains four rotary beaters which act, in succession, upon the wool, or other fibrous material, for the purpose of removing the burs, or other extraneous matters that may have become mixed therewith.

Fig. 1, represents, in vertical section, one of the beaters, with its appendages. *a,* is the beater-shaft, carrying the three blades, *b, b, b;* (the patentee does not, however, confine himself to this number,) and *c, c, c,* are pieces of sheet-iron, or other suitable material, fastened between the blades, to prevent the wool from lapping round them; *d, e,* are two pairs of drawing-rollers, which receive the wool from an endless traveling cloth, *f,* and deliver it on to the curved grating, *g;* the upper roller of each pair being fluted, and the lower one plain. The lower roller of the second pair, *d,* is furnished with a straight edge, or doctor, *h,* which is held against it by means of a small weight, *i,* hung upon a tail-piece, *j,* projecting from the doctor; *k,* is a plate secured to the curved grating beneath the lower drawing roller, *d,* and on it the wool is beaten, or dressed, as it is delivered by the drawing-rollers.

Fig. 1.

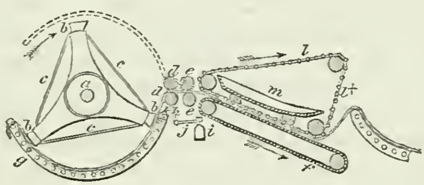


The action of the machine is as follows:—The wool, having been opened and spread upon the feeding-cloth, *f,* is carried by it to the

drawing-rollers; in passing through these rollers the wool is slightly drawn, and is then delivered to the action of the beater, by which it is carried along the curved grating to the feeding-cloth of the next beater. The wool is in this manner acted upon by all the beaters successively, and is delivered from the machine in a clean state.

Fig. 2, is a vertical section of a somewhat different arrangement for delivering the wool from one beater to another. It will be seen that the carrying-cloth, *f*, is in an inclined position, and a moving grate, *l*, is placed immediately over it. Against the upright side, *l**, of this moving grate, the wool is received when delivered from the beater behind it; the burs, &c., passing through the upright side, and falling into the tray, *m*, while the wool is drawn down by the motion of the grate, and carried forward between it and the feeding-cloth, *f*, to the drawing-rollers.

Fig. 2.



The patentee claims, firstly, the general construction and arrangement of the machine for cleaning wool, as regards the beaters being used in combination with a curved rack and drawing roller, as above described. Secondly, the particular construction of the beaters, as shown in the drawings, and the application of a doctor, as at *h*, and used in combination with a curved rack and drawing-rollers. Thirdly, the plate, *k*, on which the wool is dressed, or subjected to the action of the beaters. And fourthly, the moving grate, *l*, with its rollers and tray, on which the wool is thrown on leaving the beaters, as above described. [Enrolled in the Enrolment Office, February, 1842.]

Lond. Journ. Arts & Scien.

BIBLIOGRAPHICAL NOTICE.

The Encyclopædia of Chemistry, Theoretical and Practical. By James C. Booth, and Martin H. Boye; 8 mo.: Carey & Hart, Philadelphia.

Of the work under the above title, which is to be published in monthly parts, at twenty-five cents each, three numbers have been issued; and these have fully sustained the reputation of the gentlemen who are the editors, or, it might be more just to say, the authors, of the work. Those persons, acquainted with chemistry, who have been in the habit of examining the communications of Messrs. Booth and Boyé, as they have appeared in this journal and elsewhere, can-

not doubt their capacity to furnish a work of the kind under publication, which shall be equally and eminently useful, both to the student of chemistry, and to the professional chemist. That they have determined to justify the anticipations which their prospectus has created, is abundantly manifest from the contents of the part already published. From the rapid progress which chemistry has made within a few years, more especially in its application to the organic kingdoms, its language has necessarily become much more copious than formerly, and there is not any one work extant which can be satisfactorily employed as a book of reference, in which that language is explained, and in which the new theories that have been promulgated on the basis of the new facts discovered, are clearly presented. The work in hand will completely supply this desideratum; whilst, judging from the manner in which the articles before us are treated, every number as it appears, will be heartily welcomed by its readers.

In this age of cheap publications, when so much paper is spoiled by covering it with matter that is more than worthless, we have still the gratification of seeing many valuable works more widely diffused than was possible under the former systems; and that such will be the case with the "Encyclopædia of Chemistry," we most confidently believe, as it will be needed by every student and cultivator of a science, the value of which is being daily more fully appreciated.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Mr. Mallet's Paper on Water-Wheels.

The writer of the communication in the last September number of this journal, which is complained of by Mr. Mallet, in the following letter addressed to the editor of the "London Mining Journal," of December 23rd, 1843, requests the insertion of that letter; since he would certainly be the last to do *intentional* injustice to the well earned reputation, as an experimental philosopher, which duly belongs to Mr. Mallet; and he, therefore, regrets having been misled by the abstract of Mr. Mallet's experiments on water-wheels, which alone has yet reached America, and which certainly afforded ground for the remarks made by the writer in the September number:—

"*To the Editor of the Mining Journal.*

"*Sir,*—A paragraph appeared in your journal of the 11th of November last, stated to be copied from the "Journal of the Franklin Institute," which demands that I should beg to be permitted to trespass, in a few words, upon your columns in reply. Had the writer (who appears to be an American, and possessed of the usual share of conceit as to whatever is done at his side of the Atlantic,) examined my paper on water-wheels at length, in place of an abstract, he would have seen that no pretension is set up by me to be the originator of the 'circular conduit,' applied to overshot wheels, or even the first to determine the value of the application. The primary object of my

researches was to determine certain questions which (as far as I am informed,) the Franklin Institute *did not* determine, or meddle with; and the experiments made with respect to the use of the circular conduit, or 'close breast,' as the writer calls it, applied to the lower quadrant of overshot wheels, had special reference to the relations of my principal object, while the valuation of power was only a collateral conclusion. It is consolatory, however, to find how very close my results on this point come to those given by the Franklin Institute, although I did use 'insignificant models;' and it is worthy of observation, that the Franklin Institute has added nothing important to our knowledge, beyond what the experiments of our great Smeaton, on *his* 'insignificant models,' gave long ago. From well made and comparatively large models, better results can generally be got, when the differences of condition are properly attended to and estimated, than from observations on the great scale.

"I do not wish to be understood as depreciating the American experiments, which are really valuable, and made with great devotion of time and expense—but they neither discovered *everything* relating to water-wheels, nor set aside Smeaton's, and many others' results. My present object, however, is only to request, that by your insertion of these lines in the *Mining Journal*, you will do me the justice thus to contradict the heading to your quotation, in which you parade, in large letters, "Mr. Mallet's Close Breast for an Overshot Wheel not New;" you are yourself the first person who has called the close breast "Mr. Mallet's," and Mr. Mallet himself never claimed it, either as new, or for himself in any form—on the contrary, my paper alludes to it distinctly as an old invention.

"As to whether my researches on water-wheels are valuable or not, I am content to rest upon the opinions of some of the most distinguished of my professional brethren, as expressed in my having been honored with the premium of the Institution of Civil Engineers, for the communication describing them to that body.

Robert Mallet, Mem. Inst. C. E.

Dublin, December 15th, 1843."

There is, however, a paragraph in this letter which seems to require a passing remark, not for the purpose of exalting the experiments of the Franklin Institute beyond their real deserts, but for the sake of scientific truth. Mr. Mallet says, that the "Franklin Institute has added nothing important to our knowledge beyond the experiments of our great Smeaton," &c. Now it would be very easy to show that this Institute *has* extended our knowledge of water-wheels in several important particulars, beyond the conclusions of Smeaton. Two random examples, however, will suffice for the present.

1. Smeaton concluded that the overshot water-wheel realized *but sixty-six per cent.* of the theoretical power of the water. The Franklin Institute have shown, that when accurately constructed, "*eighty-four per cent. of the power expended, may be relied on for the effect.*"

2. Smeaton concluded, from his experiments, that "the best velocity (for an overshot wheel) is a little more than three feet" at the

skirt—though, singularly enough, he used a much higher speed in his practice, and yet never formally corrected the statements he had made before the Royal Society. The Franklin Institute have shown, that "the best velocity" ranges "*from four and a half to six and an eighth, and probably even to seven and a half feet per second.*"

Are these differences *nothing!* Will Mr. Mallet answer? And will he also say what questions he determined, by experiment, which the Franklin Institute "*did not?*" M.

Behavior of pure solutions of Sugar under different actions and circumstances; by Carl Hochstetter. *Translated by* Oehlschlager, *and communicated to the Journal of the Franklin Institute by Wm. M. Davis.*

(Continued from page 56.)

Behavior of the Cane Sugar under the combined effect of the above mentioned influences, and under circumstances as they occur in the manufacture of Sugar.

The vegetable juices of the sugar manufacturers, both the cane and the beet juice, are, as is well known, ruined with lime. These juices then become alkaline, partly from an excess of calcareous earth, partly from caustic alkalies, which have been formed by the effect of the lime upon the acids.

I have shown above that lime and the alkalies, in general, do not decompose the pure sugar in its watery solution, not even under the co-operation of heat; the question is now, what is the effect of the lime when the solutions of sugar are mixed with foreign organized substances, and when the juices, as is often the case, contain already one or more other kinds of sugar before the treatment with lime? I have already partly described the behavior of the cane sugar, under such circumstances, in the last chapter. I have shown that the transformation of cane sugar, under the influence of nitrogenous substances, at a common temperature, are not prevented by lime, but are sometimes accelerated, or, at least, promoted. I shall now consider, at the same time, the effect of heat.

When fresh beet juice, which, by the test of copper, has been found free from every kind of sugar, except cane sugar, is treated with lime, as the sugar manufacturers do at a boiling heat, *one* of the effects produced, is that combinations of lime are precipitated, the component parts of which I have mentioned in the beginning; and a *second*, that a part of the nitrogenous substances undergo, at the same time, a decomposition of which ammonia is a product. If we examine the clear juice after this, we do not find a trace of any other kind of sugar; the cane sugar has not altered, nor has the clear juice become much darker: it is of the color of a light white wine. When this juice is boiled for an hour, or longer, in an open bowl, or alembic, and evaporated, ammonia is constantly generated, whilst the liquid becomes troubled, without getting much darker than what may be attributed

to the concentration of the liquid. When we apply the test by copper, we find as yet no trace of altered sugar, supposing that the juice has remained alkaline all this time. At the same time precipitates, consisting of carbonate of lime, leucine, and of another insoluble salt of lime, have been formed.

As very small quantities had been obtained (of these precipitates) in the experiments made on a small scale, and as a more intimate acquaintance with the resulting products from alkaline beet juice, formed during the process of evaporation, could not fail to be interesting, I examined the precipitates which are constantly forming in the evaporating boilers of the sugar house of Messrs. Schmidt & Co., in Wetterhausen, near Magdeburg, and found them composed of *leucine; carbonate of lime; two salts of lime,* the one of which could be decomposed by acetic acid, the other by muriatic acid; the acids of these salts were of an organic nature, but I could not determine them; a black substance resembling *humus,* which, on being heated, swelled, melted, and smelt like burned horn; *a lime soap,* the fatty acid of which is produced by the fat which is used during evaporation.

Besides these products, also soluble salts of lime are formed, and in the juice which has undergone evaporation, we find a number of foreign organic substances changed, more or less, by the influence of the heat and the alkali.

The decomposition of the substances containing nitrogen, which I supposed, in the beginning, is completely corroborated by the precipitates in the boilers for evaporation, for leucine is formed by the action of the alkali on these substances, and in the formation of this product, ammonia must be generated. Whilst these effects and decompositions continue, the sugar undergoes no change, the reason of which is, without doubt, that as soon as any acid products are formed, (the formation of these products we must take for granted,) they are immediately absorbed by the alkali, lime, and that we cannot expect any chemical action upon the sugar from the remaining part of the products of decomposition.

To produce these phenomena, heat of an intensity greater than the temperature of boiling water, or, at least, equal to it, is absolutely necessary; for when alkaline beet juice is evaporated in a vacuum at a temperature of from 70° to 80° C., almost no precipitates appear, which might indicate a process like the above. The bright copper heating plates remain bright, for no insoluble salts of lime have been precipitated. The different behavior of the alkaline beet juice in the vacuum boilers, and in the open boilers, cannot be attributed to the influence of the air, for the formation of steam, under evaporation, is so energetic, that a contact between the air and the liquid is out of the question.

I said before that on making my experiments on a small scale, no other kind of sugar had formed under such influences, that, in general, I could not discover any decomposition of sugar, which shows that in this case also the alkalies, the calcareous earth, exercise a protecting influence over the cane sugar. I had not an opportunity of

examining these facts on a large scale, and before that time I was unacquainted with the test by copper.

The phenomena are different when, as it is often the case, the beet juice has undergone some change before it is treated with lime, particularly when it contains fruit and grape sugar.

These two kinds of sugar manifest a behavior completely different from that of the cane sugar, when acted upon by alkalies. When these sugars are dissolved in water, and mixed with lime water, or the milk of lime, they undergo a complete decomposition, even at a common temperature, but a lasting effect is required. When acted upon by heat, these changes proceed very rapidly, and the more energetically the higher the temperature to which the alkaline solutions of these sugars are exposed.* The products which are formed have not been much examined hitherto; among others, several acids, glacic and melassic acids. The products of decomposition seem to resemble those which are formed by the concentrated action of acids upon cane sugar.

A solution of sugar which contains only the smallest portion of another kind of sugar, when heated with lime water becomes darker almost immediately. Lime water, or a solution of sugar in lime water, therefore presents to us a reagent (test) to discover another kind of sugar in a colorless solution of sugar. If a sufficient quantity of fruit, or grape, sugar be contained in an alkaline solution, the alkaline property disappears entirely after a short time, and more calcareous earth can be precipitated by means of carbonic acid.

On mixing the solution of a quantity of grape and fruit sugar with a concentrated solution of sugar in lime, and obtaining a liquid of about 20° B., not a trace of the foreign sugar could be discovered after two hours; they had been completely decomposed. The cane sugar of the sugar lime had remained unaltered during this process, that is to say, as long as there remained still some free alkali. The fluid in the mean time changed to a dark brown color, and precipitates had formed. When the quantity of the alkali is small, the action is not so intense.

I now revert to the beet juice, supposing that besides the cane sugar there are other sugars before the treatment with lime commences. In this case a very different phenomenon appears, from those observed in the good, pure juice of the cane sugar; the clear juice becomes colored, and, according to the state of the juice, assumes either a yellow, a bright yellow, or a reddish yellow color. The calcareous earth, and the other free alkalies, have immediately exercised their influence over the other sugar, and the result is the same as when a colorless solution of cane sugars is changed by the action of nitrogenous substances under the influence of the air, and at a common temperature. When the quantity of foreign sugar is large, the effect of the alkalies will continue during the process of evaporation, and as long as there is any free alkali and sugars, which can be decomposed by these substances.

* See Péligot's Inquiries into the Chemical Properties of different Sugars; Annals de Chimie, vol. vii. p. 113.

This is the reason why bad juices, although strongly alkaline, entirely lose their alkaline properties during the evaporation. This effect, it is true, cannot be entirely accounted for by the pressure of foreign sugars, but part of it must be attributed to the larger quantities of materials containing nitrogen, not to be separated by boiling, nor by the use of lime, and which are always found in greater quantities in bad, or altered, beet juice, than in unaltered beet juice; these, in their process of decomposition, absorb a part of the alkali. Beet juice strongly alkaline, will, by the test of sugar, indicate no other kinds of sugar, because they have been destroyed by the action of the alkalies.

I stated before that in unaltered alkaline beet juice no cane sugar is transformed, during evaporation, over a free fire. The copper test was not the only reason I had for this assertion, as, in this case, it might be deceptive, for, if another kind of sugar were formed during the boiling of the alkaline juice, it would be immediately destroyed by the action of the alkalies. If, however, in the above case, cane sugar had been transformed, such a change would have immediately manifested itself by a strong coloring of the liquid.

This aberration finally leads us to the conclusion, that in the beet juice, and, undoubtedly also in cane juice, which, before being treated with lime, contained no other but cane sugar, during evaporation, even over a free fire, and a temperature above that of boiling water, no cane sugar is decomposed; supposing that the fluid remained always alkaline, and that the coloring matter of the evaporated juice is the result of the soluble decomposed products of the nitrogenous materials.

If, however, the beet juice, before the treatment with lime, contained other kinds of sugar, the evaporated juice will also absorb through the actions of the alkalies, the products of the decomposition of the sugars, but again without any cane sugar being transformed. These products are generally soluble in sugar juice, and contain much coloring matter.

The result of these inquiries indicates several agents under the influence of which an alteration can take place in the cane sugar during the manufacture, or which may cause a decrease in the yield of cane sugar. As a synopsis, I here condense this part of my labor under the following propositions:

1. A pure solution of sugar is changed through the influence of atmospheric air at a common temperature, and the more readily the more numerous the surfaces are which bring them in contact. This process is considerably heightened when the solution of sugar contains nitrogenous substances, such as they occur in the saccharine juices of the beet, and of the sugar cane. The change consists in the formation of a new kind of sugar, undoubtedly fruit sugar. The presence of substances containing nitrogen, produces a secondary change, the so called mucous fermentation, but under certain circumstances also a vinous and a milky fermentation may be the secondary result.

2. The decomposition of a pure solution of sugar in boiling, during a space of time equal to that of the boiling operation on a large scale

goes on imperceptibly, whilst the change is perceptible when the solutions contain nitrogenous substances, all the remaining circumstances being the same.

3. The alkalies (the calcareous earth) do not change the sugar in its watery solution, not even in a temperature as high as 120° C., (248° Fahr.) They protect the sugar against the action of the decomposed materials of the substances containing nitrogen at a higher temperature. Under certain circumstances alkalies can promote a transformation of the sugar, namely, when there are substances containing nitrogen at a temperature which favors the process of fermentation.

4. The nitrogenous substances contained in the beet are qualified to change the cane sugar, both at a common temperature, and at boiling heat; in the former case the same changes take place which have been mentioned in 1. In the second, new kinds of sugar, undoubtedly fruit and grape sugar, are formed by the decomposed products of these substances.

5. Most salts, particularly the alkaline chlorides and earths, impede the crystalization of the cane sugar, without producing decomposition, or change. The action seems to be purely mechanical, for the sugars unfit for crystalization, act in a similar manner.

6. The influence of acid substances, of every kind, for forming grape and fruit sugar in the solutions of cane sugar, according to circumstances, and in different proportions, I have not examined more closely, as this influence has probably been observed more accurately than any other.

III.—*Application.*

We have seen that many causes can effect the cane sugar during its preparation, and trials on a small scale alone are insufficient to know to which causes the greater part of the change which the manufacturer, to his sorrow, observes in the, so called, molasses, are to be attributed; since we know for certain that neither the sugar cane, nor the beet, contains any other than cane sugar, the formation of molasses can only be attributed to decompositions which the layer undergoes during its preparation. It is true the molasses (sirop) of the sugar refiners does not solely consist of transformed cane sugar; but it does so for the greatest part. They contain, besides salts, coloring matter, and other substances no further characterized, yet a considerable quantity of cane sugar.

Although it is impracticable, on a large scale, to obtain from the *sirop* more sugar capable of crystalization, it is possible, particularly with the molasses, or sirop, of the beet sugar manufacturers, by the use of much coal and spirits of wine, to extract still a large quantity of crystalized cane sugar from them: to obtain all the sugar, is, however, impossible. Soubeiran, by means of a polarization apparatus, has examined several kinds of molasses, (sirops) and has calculated that they contain of cane sugar about 50 per cent.* Ventzke has found still greater quantities, as much as 60 per cent. The whole

* After deducting the water which the molasses contains.

mass of sirop obtained in reality, can, therefore, not be considered as the products of decomposition, for, as I have shown before, small quantities of salt possess the quality of preventing the appearance of cane sugar in a crystalized form, and combined with it to form a sort of sirop. The same influence is exercised by the sugars which do not crystalize; several experiments have convinced me that this is the case.

Whether the sirop of the sugar house contain much, or little, cane sugar, it is a fact, that by common means it cannot be extracted in a crystalized form, and knowing that foreign kinds of sugar, the decomposed products of the cane sugar, make the latter unfit for crystalization, the question remains of equal importance, to which causes the decomposition of the cane sugar, during its preparation, ought to be properly attributed.

I have shown that cane sugar of an alkaline beet juice, which, during constant boiling, is allowed to evaporate over a free fire, does not change any more than during the, so called, process of clarifying. In these two operations, therefore, the influence of heat contributes in no way to the formation of new sugar. If we take it for granted that heat is one of the most injurious agents during the process of manufacture, it could only act whilst the sugar is being boiled down, and then decompose the cane sugar.

I have proved that solutions of sugar, at a temperature above that of boiling water, which contains nitrogenous substances, can be changed by indirect means. This is the case during the boiling down of the sugar, when it is without a protecting substance, such as lime, or other free alkalies. In the better arranged sugar houses they use vacuum boilers to boil down the sugar, both in the preparation of the beet sugar, and the refining; in these the temperature never reaches that of boiling water, and by this means the influence of the heat is considerably modified. Soubeiran has also shown, that when sugar is boiled down in a vacuum, the saccharine juices do not perceptibly change, having found that the aqueous solution showed the same capacity of polarization, after the process of boiling down, as before. When the sugar is boiled down at a low temperature, as in a vacuum, it does not undergo any change in consequence of the heat.

I shall not attempt to decide whether, when the boiling down is effected, under the common pressure of the air by means of steam, or over a free fire, a large quantity of sugar is decomposed, but it has been found, on a large scale, that the difference in quantity and quality between sugar houses, which perform all their operations of boiling in a vacuum, and those which perform them carefully over an open fire, is very trifling.

It is not improbable that so much attention has been bestowed upon the apparatuses of boiling, under the supposition that the production of sirop was particularly owing to the influence of a high temperature. I think that the decomposition ought to be attributed to other causes.

According to the knowledge we possess of the manufacture of sugar in tropical countries, the juice of the sugar cane evinced a pecu-

liar liability to undergo fermentation when favored by a high temperature, so that we may suppose that a great part of the original cane sugar is already altered before the juice is subjected to any other operations. The appearance of the phenomena of fermentation is by no means necessary for the transformation of cane sugar, for the signs of fermentation always indicate a previous transformation of cane sugar into other kinds, either grape or fruit sugar.

The inferior cane sugars of the colonies continue to change during their long voyages; these changes must be considered as processes of fermentation; sometimes the cane sugars are sour, probably from milk acid, sometimes mucous, or gummy, products are formed, but a change always takes place.

When the cane sugar comes at last to our sugar houses, it is treated with the greatest precaution, and boiled in a vacuum, so that no cane sugar can be decomposed; a part of the sugar, in the form of sirop, again undergoes a change, in case the sirop remains for a long time on the floors of the sugar houses.

All those who have had an opportunity of observing the effect of certain substances containing nitrogen, upon concentrated, or diluted, solutions of sugars, must confess that the circumstances under which the colonies manufacture and ship their sugar, point out the effect of these substances as the principal cause of the changes of the sugar capable of crystalization.

The juice of our native saccharine material, the beet, would, undoubtedly, at the high temperature of the tropical climates, change still more rapidly and energetically, than the juice of the cane, because the beet contains a much larger quantity of substances producing fermentation. Fortunately our time of manufacturing is in the winter. We perceive, notwithstanding, that the juice of the beet changes as soon as it leaves the cells of the beet, and the more readily the higher the temperature of the pits, where they have been kept, and the higher that of the air are. In good sugar houses care is taken that no perceptible changes take place, that the juice becomes sour and mucous, but it often changes without these indications. The changes always depend upon the state of the beet: in the fall, when the beet is used immediately after the harvest, the temperature does not affect it perceptibly; as early as January and February, it is observed in all sugar houses, that as soon as a thaw commences, and the temperature rises, the yield is less, and of inferior quality, but as soon as the weather changes again to cold, more and better sugar is obtained from the same beet.

In beet which has commenced sprouting, no foreign sugar is found, no more than in beet which is fresh, and has not been sprouting, but we observe a change in the substances containing nitrogen, upon which depends, in the spring, the more rapid change of the beet juice, even at a temperature only a few degrees above the freezing point.

As I have shown before, we are not able to separate, with lime, the whole of the substances containing nitrogen, from the juice, considerable quantities remain behind, and these quantities are in proportion to the changes which the juice has undergone; we know,

moreover, that all alkaline clarified beet juice, under the influence of the air, and other favorable circumstances, can change, and by a process of fermentation, can be entirely decomposed.

Whenever clarified, or evaporated, beet juice presents to the air large surfaces of contact, at a high temperature, and is allowed to stand for any length of time, moments which favor the transformations occur. This does not cease even when the sugar is in the mould, for the first sirops being left to themselves for some time the floors are undergoing constant, though slow, changes; the more the sirop is diluted, the more rapidly do these changes proceed.

At almost every period of the manufacture, we perceive the same causes of change which I have described under the influence of substances containing nitrogen, and, I think, that I can vouch for the correctness of the opinion, according to which the real decomposition of the cane sugar takes place alone under the influence of these substances, supposing that the operations, when no alkaline juices are boiled, are performed in a vacuum, and that whenever all the operations are carefully performed, upon a free fire, only the smallest part of the changes can be attributed to the elevation of the temperature. Another consideration might not be amiss here, namely, how far the method of preparing the sugar, the manipulations and apparatus hitherto in use, have answered their purposes.

The saccharine juice is extracted from the beet by two different methods, by expression and maceration of the fresh beet root, or by steeping the dried substances of the beet.

The present improved mechanical utensils for expressing the juice of the beet, perform this operation so quickly, that a change seems almost incredible; but the juice becoming black, we see that a change can occur. This change has, as experience teaches us, no evil consequences; it is, on the contrary, considered as a sign of the goodness of the juice, but it proves at the same time how quickly such a transformation is effected. In most sugar houses single masses of juice are allowed to stand for hours in the reservoirs, if a careful separation of the masses of juice which are extracted at different periods, is not attended to, because no preparation to this effect has been made in the construction. On the sides of the reservoirs, and of the other utensils, thin layers remain exposed to the air for a long time; they change, and mixing with fresh juice, cause a considerable transformation. The partitions and press cloths are the cause of still greater fermentation. To succeed, all these evils should be carefully avoided.

The adherers to the maceration system, mention as a principal advantage of their manner of proceeding, that in boiling the slices, or generally, the fresh mass of the beet, the albumen coagulates, whereby the fermenting properties are destroyed in the juice, and the cause of the failure, where the press is used, is removed. This, however, is a great error, which, all those who have ever attempted to extract sugar by this method, must have discovered.

By the boiling of the beet only a part of the substances containing nitrogen is precipitated, lime also effects only a part of it, as it forms in soluble combinations; a considerable part, and the very part which

is most likely to induce a transformation, is dissolved in the juice. It is true that the heat modifies the effect of these substances considerably, nay, for a time destroys it; but in a favorable temperature, and in contact with the air, they soon regain these properties.

The maceration of the beet, in the best maceration vessels, (tubs) requires six hours; an exact separation of the different masses of juice from every maceration, is, on a large scale, very difficult; wherefore some parts of the juice remain frequently a long time exposed to influences favorable to fermentation, change and finally involve the whole mass in a process of decomposition. These circumstances hitherto caused the failure of all the methods of macerations. The adding of lime during the process of maceration does not prevent a decomposition, it may, on the contrary, promote it. Very large quantities of lime can arrest it, but not unconditionally.

I have observed a lively fermentation in strongly alkaline juice; in the vessels for maceration, bubbles of carbonic acid arose, and lactic acid was formed. As long as the process of maceration cannot be performed in a very limited time, we cannot expect any favorable result from this method.

To separate these foreign substances, contained in the juice of the beet, at present only lime is used; this material, as I have shown, exercises no injurious influence, but it is insufficient, for it leaves a quantity of substances, the removal of which would be desirable, in a state of solution. Only under certain circumstances does it produce a pernicious effect upon the manufacture. This is the case when the beet juice, before being treated with lime, or before the process of evaporation, contains foreign sugars, for they become decomposed by the alkalies, and add to the quantity of foreign materials, some of which contain strongly coloring matter.

If, therefore, in the *one* case, great additions of lime only operate prejudicially, in as far as the calcareous earth must be removed before the boiling down, which requires either acids, a substance we do not like to make use of, or bone coal, which is expensive; large additions of lime, in the *second* case, moreover produce the injurious effect, that they decompose the foreign kinds of sugar contained in the juice, and, with the products, color the raw sugar, and deteriorate the molasses. In such cases it would be advisable, particularly during the process of evaporation, to keep the juice as little alkaline as possible; but, during the evaporation, to add gradually as much as is necessary to preserve the alkaline property in the juice.

I have shown that the cane sugar in the alkaline juice, during the evaporation at a common pressure of the atmosphere, does not undergo any change, that only the substances containing nitrogen are decomposed by the combined influence of heat, and of the alkalies, but without any pernicious effect upon the sugar, forming partly soluble, and partly insoluble compounds.

For this reason the evaporation of alkaline juice in a vacuum appears to me useless. According to my experience, when part of the same juice was evaporated to 25° B., in a vacuum, on a large scale, and part in an open evaporation boiler, the latter produced a better

result than the former, and this phenomenon was the more striking the worse the beet was, of which the juice had been evaporated. By means of my experiments and observations, on a small scale, I think that I can account for this.

When clarified beet juice is evaporated, in a vacuum boiler, at a temperature of 70 – 80° C., (158 – 176° Fahr.) precipitates which are scarcely perceptible are formed; they consist of fine, suspended flakes, evidently because the temperature was too low to decompose the foreign organic substances. Whatever alkalies and foreign organic substances the juice may contain at this temperature, no remarkable separations are formed. After evaporation, this juice, therefore, contains still all the foreign substances in a state of solution, a great part of which becomes separated at a higher temperature. The juice evaporated in open boilers, is, therefore, much purer than that which has been evaporated in a vacuum, and as in neither case foreign sugars are formed, or cane sugar is decomposed, the former must produce better results.

This also explains why, with inferior beet juice, the advantages of evaporation are still less apparent, for such juice contains generally a still greater quantity of foreign substances in a state of solution, which form isolated, sticky, and mucous materials, and become very detrimental to the crystalization of the sugar. Through the influence of heat and alkalies, these materials undergo a change when boiled under the common pressure of the air, and lose their sticky, and, at the same time, paste-like quality, without mentioning those decomposed products which are no longer in the sugar solution as insoluble. The advantages which are expected from performing all the operations of boiling in a rarified atmosphere, are, therefore, very illusive.

Those systems of evaporation where beet juice drops over warmed surfaces, (plates) and, by great contact with the air, loses its water, which evaporates, ought to be rejected altogether. The temperature in these systems of evaporation is generally too low to exclude the dissolving influence of the nitrogenous substances, and to avoid changing the sugar, although the juice contains alkali.

Systems of evaporations have also been introduced by which hot air is forced through the juices ready for evaporation, and by which means the evaporation of the water is effected. The economical advantages will not easily induce the manufacturerer to adopt this proceeding, although it is true that even here alkaline solutions of sugar will not easily undergo a change, taking it for granted that the temperature of the evaporating fluids approaches the boiling heat of water.

Contrary to a general opinion, I have always made the observations on a large scale, that when evaporation is effected at a temperature lower than 100° C., (212° Fahr.) the results are more greasy than those obtained by other systems of evaporation. To avoid being misunderstood, I should mention here that I am speaking of cases as they usually occur in the manufacture of sugar. Where excellent beet, containing very pure juice, is used, a smaller difference will be found in the products, in consequence of the application of different

methods of evaporation, unless they are altogether irrational, and the work is otherwise not properly directed, than where beet is used, the juice of which, on account of its many foreign substances, presents greater difficulty in the preparation.

When the saccharine juice is to be evaporated (inspissated) for crystalization, it ought to contain as few foreign substances as possible; they all prevent the forming of sugar crystals more or less, and, therefore, the excess of lime which commonly remains in the juice after evaporation ought to be removed. The application of sulphuric acid for this purpose requires much caution, and, besides this, not inconsiderable quantities of gypsum, are dissolved in the liquid; the animal coal is too costly a material for this purpose. In more recent times carbonic acid, extracted from coal by burning it, has been proposed and applied. As far as I know, the lime had been already precipitated in the saccharine juice before evaporation, wherefore it contained but little alkali, when this process commenced; as it appears, however, from all that I have already said on this subject, that alkaline properties in the juice are useful, the application of the carbonic acid appears only advantageous after the evaporation, if economical considerations do not prevent its use altogether.

The animal charcoal is the only means which has hitherto been employed, on a large scale, to brighten the color, and to remove the foreign organic, or inorganic, substances; and it would answer the purpose perfectly, if its high price did not put limits to its application. The removal of so many different foreign bodies from the juice without injury to the sugar, by any means, but that of absorption, similar to that of the coal, can scarcely be considered as practicable.

A cheap and easily procurable substitute for the animal charcoal now in use, would give a new impulse to the manufacture of beet sugar; if we could succeed in removing, by a simple and cheap process, the salts and organic substances with which the beet abounds, and which renders the preparation so difficult, being, in a great measure, the cause that the yield of crystalized cane sugar is so small, our inland manufacture would obtain a considerable preponderance over that of the tropical climates.

The juice ready to be boiled down for crystalization, can, in very few cases, contain alkaline properties, and in this process the higher temperatures, can, therefore, produce, upon the solutions of sugar, a greater effect than in all the operations which precede the boiling down; here, therefore, the application of vacuum boilers appears to be justifiable.

On Bleaching Salts. By M. Detmer, Esq.

A short time ago a notice was published, by M. Millon, on the Bleaching Salts of Chlorine, in which a new view was offered of the constitution of these compounds. They have for some time past generally been considered as compounds, or mixtures, of a metallic chloride with a hypochlorite of a metallic oxide; bleaching powder,

or the chloride of lime, for instance, as consisting of chloride of calcium, and hypochlorite of lime, in single equivalents, the acid of the last salt containing one atom of oxygen, to one atom of chlorine. The reaction of chlorine upon lime supposed, may be very simply stated: two atoms of lime take up two of chlorine; one atom only of the lime is decomposed, of which the calcium and oxygen respectively unite with an atom each of chlorine, forming chloride of calcium, and hypochlorous acid. The hypochlorous acid combines with the other atom of lime.

Starting from the composition of chlorochromic and chloro-sulphuric acids, which are represented by Walter and Regnault, as chromic and sulphuric acids in which the third proportion of oxygen is replaced by chlorine ($Cr\,O_2+Cl$ and SO_2+Cl,) Millon supposes that the bleaching chlorides have a similar relation to the peroxides of their metals. The peroxide of calcium being $Ca\,O_2$, or $Ca\,O+O$, bleaching powder is $Ca\,O+Cl$, or the peroxide of calcium, with chlorine substituted for its second proportion of oxygen. In support of this view, Millon adduces observations of his own on the composition of the bleaching compounds of chlorine with different metallic oxides, such as oxides of lead, and protoxide of iron, as well as potash, soda, and lime, in which the proportion of chlorine was found to vary, but to correspond with the excess of oxygen, above one equivalent in the peroxides of the same metals. In particular, potash was found to absorb two equivalents of chlorine, and soda only one, the peroxide of potassium being $K\,O+2\,O$, while the peroxide of sodium is $Na\,O+O$.

The attention of the author was particularly directed to ascertain the accuracy of the latter statement. A solution of carbonate of soda was charged with chlorine gas, till it acquired a yellow color, and retained not a trace of carbonic acid. The solution was then briskly agitated with air, by which the excess of free chlorine escaped. In analyzing the solution afterwards, one portion of it was treated with a few drops of ammonia, and the chlorine afterwards precipitated by nitrate of silver; another portion was evaporated to dryness for the sodium, which was obtained in the state of chloride of sodium.

In four experiments the liquids charged with chlorine, contained chlorine and sodium in the following proportions, in 100 parts:—

Sodium,	47.88	45.26	46.81	44.76
Chlorine,	52.12	54.74	53.19	55.24

while, if the bleaching chloride of soda contained 1 eq. of chloride to 1 eq. of soda, its composition would be

1 eq. sodium,	46.91	
1 eq. chlorine,	53.09	
		100.00

The results correspond as closely as could be expected with this theoretical statement. There can be no doubt then that the chloride of soda contains one of chlorine to one of soda. This is the result required by Millon's theory, the peroxide of sodium containing, accord-

ing to him, one of oxygen, and one of soda; but it is equally consistent with Balard's theory, that the salt is a mixture of single equivalents of chloride of sodium, and hypochlorite of soda. To determine the quantity of chlorine which water dissolves, a stream of the gas was sent through water at 59° for five hours. One hundred grammes of water were found to take up 0.663 gramme of chlorine; or 200 cubic inches of water dissolved 207 cubic inches of gas. The chlorine was estimated by converting it into hydrochloric acid, by the addition of a few drops of ammonia, slightly acidulating afterwards by nitric acid, and precipitating by nitrate of silver. A solution of 2.58 chloride of potassium in 38.96, water was found to dissolve less chlorine than pure water, in the proportion of 180 to 257. Chlorine gas being allowed to stream through a solution of 9.245 grammes carbonate of potash in 96.495 grammes of water, till saturation, the solution lost all its carbonic acid, and took up 6.631 grammes of chlorine. Here 1 eq. of potash = 590 has taken up 656 chlorine, which is very nearly $1\frac{1}{2}$ eq. of chlorine = 663. But when the quantity of free chlorine in the liquid is deducted, the latter is found to contain only 1.34 equivalents of chlorine to 1 eq. of potash. In two other experiments, in which the liquid was agitated with air after being saturated with chlorine, to allow the excess of gas to escape, there were found to 1 eq. of potash 1.44 and 1.43 equivalents of chlorine. The carbonate of potash, therefore, without doubt, takes up more than a single equivalent of chlorine. But the quantity of chlorine combined with the potash is still greatly short of two equivalents, the proportion required by M. Millon's theory; the peroxide of potassium containing two oxygen to one potash, or $K\,O_2$. The conclusion, therefore, is inadmissible, that the chloride of potash is analogous, in constitution, to the peroxide of potassium.

It remains to account for the property which potash is found to possess of taking up more chlorine than is necessary to convert it into chloride of potassium, and hypochlorite of potash. On transmitting chlorine through carbonate of potash, a stage in the absorption is very observable, at which the liquid becomes all at once of a yellow color. This happens when what remains of the potash is entirely converted into bicarbonate of potash. The suddenness of the appearance of the yellow color, appears to be due to a reaction of the carbonic acid upon the hypochlorite of potash in solution, by which hypochlorous acid is set free, and tinges the liquid. By the continued application of chlorine to the bicarbonate of potash, it is converted into a mixture of chloride of potassium, hypochlorite of potash, and free hypochlorous acid. By the ultimate action of the chlorine, all the bicarbonate of potash is decomposed, the carbonic acid entirely expelled, and a portion of hypochlorous acid remains free in solution.

This formation of free hypochlorous acid does not occur with carbonate of soda, owing to the much weaker affinity which that base has for carbonic acid, and its forming a much less stable bicarbonate than potash does. The free carbonic acid cannot, therefore, re-act upon the hydrochlorite of soda, and liberate hydrochlorous acid as the free carbonic acid does upon the hypochlorite of potash. The same

formation of free hypochlorous acid occurs in a more striking degree when chlorine is sent through a solution of acetate of potash; that solution, it is well known, absorbs a large quantity of gas, and acquires the strong yellow color, the odor, and all the other properties of free hypochlorous acid. It is here evident, that by the action of chlorine upon acetate of potash, chloride of potassium is formed, with the binacetate of potash, free hypochlorous acid, and the hypochlorite of potash. If the large absorption of chlorine, by carbonate of potash, is due to carbonic acid, it follows that caustic potash should not absorb any excess of chlorine, but that the property should be confined to the carbonate. Accordingly, in two experiments, the proportion of chlorine, absorbed by caustic potash, was found to be as nearly as possible a single equivalent. In one experiment 449.1 chlorine, in the other 424.8 chlorine were taken up, instead of 442.6 chlorine, by a single equivalent, or 589.9 of potash. Caustic potash, therefore, dissolves no more chlorine than caustic soda. There appears, therefore, to be no reason to abandon the old theory, that the bleaching solutions of chlorine in alkalies and alkaline earths, contain a chloride and hypochlorite, for these bleaching compounds certainly do not correspond with metallic peroxides, as has been lately maintained.

Mem. Chem. Soc., Lond.

On some of the Substances contained in the Lichens employed for the preparations of Archil and Cudbear. By Edward Schunck, Esq., *Manchester.*

Our knowledge concerning that department of organic chemistry which embraces the coloring matters, and other principles nearly allied to them, is of the most imperfect kind. Though many other branches of organic chemistry have been so thoroughly and accurately investigated, that little or nothing remains to be known concerning them, this may be called an unexplored field. Most of the coloring matters are so little known, as regards even their most essential characters, as not to allow us either to justify, or to question, the propriety of throwing them together into one general class; a class distinguished from those nearly allied to it merely by the (as far as we know) adventitious circumstance of the substances belonging to it, being endowed with certain more or less vivid colors. Among all the coloring matters, there are none, the study of whose properties and reactions is calculated to throw more light on the nature of the whole class, than those which are prepared by an artificial process from certain kinds of lichens, and on this account it is desirable that they should be carefully examined. It was the circumstance of these substances being prepared artificially from plants perfectly devoid of color, that first attracted to them the attention of chemists, and led to a series of investigations by which a number of highly interesting substances was brought to light, and a process elucidated which belongs to the most remarkable and unparalleled in the whole range of organic chemistry.

Robiquet first discovered a colorless crystalizable substance in them (orcin,) capable of being converted by the joint action of ammonia and oxygen into a true coloring matter, which contains neither the original substance, nor ammonia as such. This interesting discovery was followed by others. The researches of Heeren made us acquainted with a series of substances contained in the *Roccella tinctoria*, possessed of the same property, and another substance, phloridzin, was shown, by Stas, to bear a complete analogy to orcin, in this respect. The subsequent labors of Dumas, who subjected orcin, and the bodies derived from it, to an accurate examination, and of Kane, who has determined the composition of the substances discovered by Heeren, and of the coloring matters contained in archil and litmus, seemed to have sufficiently elucidated the subject. Some obscurities, however, in a part of Dr. Kane's late paper, seemed to make it desirable that some of his results should be confirmed before being finally adopted, and, at the suggestion of Professor Liebig, I undertook the reinvestigation of this subject, and performed it in his laboratory.

Instead of the *Roccella tinctoria*, I employed, in my experiments, the lichens that grow on the basalt rocks of the Vogelsberg, in Upper Hessia, where they are collected for the purpose of preparing a dye from them. These lichens were all crustaceous, and belonged to the genera *Lecanora*, *Urceolaria*, *Variolario*, &c. From them I extracted the following substances:—

1. A white, crystaline substance, soluble in alcohol and ether, but insoluble in water, bearing in its properties great resemblance to the substance called by Heeren *Erythrin*, and by Kane *Erythrilin*, but different in composition, and giving other products of decomposition. This substance I call *Lecanorin*.

2. A crystalizable substance identical in properties and composition with Heeren's *Pseuderythrin*, and Kane's *Erythrilin*.

3. A fatty substance of acid properties, soluble in alcohol, but insoluble in ether and water.

The method by which these substances were extracted, and separated from one another, was the following:—

The lichens were reduced to a coarse powder, and then treated with ether, in an apparatus of displacement, until the ether dissolved nothing more. The ethereal extract, which had acquired a green tinge from chlorophyl in solution, was distilled off, leaving as a residue a greenish yellow mass, consisting, for the greater part, of lecanorin. This mass was brought into a glass funnel, and washed with small quantities of ether, until it had lost its green color in part. It was then treated with boiling water, in order to remove every trace of pseuderythrin, and, lastly, purified by dissolving it in a small quantity of boiling alcohol, which deposited, on cooling, a snow-white crystaline mass, consisting of lacanorin in a state of purity. The dark green ethereal fluid obtained by washing the impure lecanorin, contained, besides lecanorin, the greatest part of the pseuderythrin which had been extracted by the ether. The fluid was evaporated to dryness, and the residual mass treated with boiling water, which deposited, on cooling, a mass of shining plates and needles of pseuderythrin,

which was purified by recrystalization. More of this substance was obtained by treating the lichens, which had been exhausted with ether, with boiling alcohol, and filtering rapidly. The alcohol was distilled off, and the residue treated with boiling water, which dissolved all the pseuderythrin, and deposited it on cooling. The mass left undissolved was washed with ether, which dissolved all the chlorophyl, and left behind the fatty substance mentioned above, which was purified by redissolving in alcohol.

I will now proceed to a more minute description of the properties of these several bodies.

Lecanorin.—This substance, when pure, is perfectly white. If prepared in the manner described above, it has the appearance of a white mass composed of acicular needles. When its solutions are slowly evaporated, it crystalizes in silky needles grouped together in star-shaped masses. It is insoluble in boiling water, but soluble easily in alcohol and ether. Its solutions redden litmus paper. It is soluble in alkaline liquors, from which it is precipitated unchanged by acids, provided the solutions be not boiled, and be not left to stand too long. It is insoluble in all weak acids, with the exception of acetic acid. Strong nitric acid converts it ultimately into oxalic acid. It combines with metallic oxides by double decomposition. Heated on platinum foil it melts, emits a dense vapor, and burns off, leaving but little carbonaceous residue. When heated in a tube closed at one end, it melts, and, under violent ebullition, gives off a dense vapor, which condenses in the upper part of the tube into a thick liquid, which, after some time, solidifies, forming a crystaline mass. The nature of this sublimate will be explained further on.

The action of the alkalies on this substance, is, of course, the most interesting point connected with its history. A solution of lecanorin in ammonia, when exposed to the air, acquires, after some time, a beautiful deep purple color: from this solution acids precipitate a red coloring matter. A solution in potash, under the same circumstances, becomes of a deep red color. Being desirous of ascertaining whether the lecanorin was immediately converted into the red coloring matter, or whether it passed first through any intermediate state, which was not improbable, I dissolved some of the substance in ammonia, excluding the solution from contact with the air. After a lapse of some hours, the solution, though perfectly colorless, was found no longer to contain any lecanorin; for acids, instead of producing a thick gelatinous, or flocculent, precipitate, as they do when applied immediately after solution has been effected, merely caused a brisk effervescence of carbonic acid, plainly showing that the substance had been completely decomposed without a coloring matter having been formed. The same effect was brought about instantaneously when the solution was boiled. In order to observe the process more clearly, I dissolved a quantity of lecanorin in baryta water in the cold. The solution, on being boiled, or allowed to stand, deposited a great mass of pure carbonate of baryta. The liquid was filtered rapidly, and the excess of caustic baryta precipitated by a stream of carbonic acid: on slow evaporation, it yielded large prismatic crystals of a substance which

possessed characters in every respect identical with those of *orcin.* It had an extremely sweet taste, was capable of being volatilized without change, and without leaving any residue; gave a deep blue color when dissolved in ammonia, and exposed to the air, struck a blood-red color with nitric acid, and precipitated a solution of basic acetate of lead. Lecanorin thus is converted, by the action of alkalies, into orcin and carbonic acid, in the first instance, this decomposition always preceding the formation of coloring matters. The same decomposition is produced by the carbonated alkalies, by long boiling with water, and by dry distillation, the heavy vapor, mentioned above as being produced by heating lecanorin to decomposition, being vapor of orcin.

The composition of lecanorin is expressed by the formula $C_{18} H_8 O_8$. The results of the combustions which I made of it, admit of no interpretation. All attempts to determine its atomic weight by means of combining it with metallic oxides, failed. These compounds can only be prepared by double decomposition; but the facility with which lecanorin is decomposed, when alkalies are added to its solutions, always renders the purity of the compounds formed liable to doubt. The compound with oxide of silver, formed by adding nitrate of silver to an alcoholic solution of lecanorin, and then precipitating by means of a few drops of ammonia, though it changed color but slightly in drying, gave no consistent results. The compound with oxide of lead, formed by precipitating a solution of lecanorin with basic acetaté of lead, was so basic, and its formula so unusual, that I am led to suppose that one or two atoms of basic acetate of lead were precipitated together with it. By decomposing, however, a weighted quantity of lecanorin with caustic baryta, and determining the quantity of carbonate of baryta formed, I obtained very accurate results, confirming the formula $C_9 H_4 O_4$, or $C_{18} H_8 O_8$, for lecanorin. In regard to the composition of orcin, I have been induced to replace the generally received formula, for its composition, by a new one. Dumas' formula for anhydrous orcin is $C_{18} H_7 O_3$, and for crystalized orcin $C_{18} H_{12} O_8$, which evidently cannot be brought into accordance with the formula for lecanorin as given above. If, however, the formula $C_{16} H_6 O_2$, be taken for anhydrous orcin, and $C_{16} H_{11} O_7$ for crystalized orcin, then the decomposition which lecanorin undergoes with alkalies, may be expressed as follows:—

1 atom of anhydrous orcin,	$C_{16} H_6 O_2$
2 atoms of water,	$H_2 O_2$
2 atoms of carbonic acid,	$C_2 O_4$
1 atom of lecanorin,	$C_{18} H_8 O_8$

Two atoms of water are furnished by the decomposition of the lecanorin itself, and three more by the fluid, to form from $C_{16} H_6 O_2$ one atom of crystalized orcin, $C_{16} H_{11} O_7$. The combustions which I have made of this substance agree perfectly with these formulas, but Dumas' analyzes of the lead compound of orcin, which I have myself not yet examined, do not coincide with them, unless it be supposed

that this compound contains acetate of lead, either in chemical combination, or mechanically mixed.

In regard to the numerical results from which the above formulas have been deduced, I shall reserve them for a future occasion, when, having completed the investigation of the whole class of substances of which those here described are only a part, I shall be able to enter more minutely into details, and exhibit the facts and numbers brought to light in their proper connexion and order. I have merely been desirous of showing, on the present occasion, that our knowledge of this series of bodies is far from being complete. I have shown above, that the action of alkalies on lecanorin is two-fold; it consists, first, in abstracting from the substance carbonic acid, a process not requiring the co-operation of the oxygen of the atmosphere; secondly, in inducing, in contact with the air, the formation of coloring matters. The first action seems to have been overlooked in the case of all the bodies nearly allied to lecanorin. I have found the most complete analogy in the case of Heeren's pseuderythrin; and, if I am not mistaken in the interpretation of his statements, his erythrin also undergoes the same decomposition as lecanorin, for the former is converted into erythrin-bitter, by the very same agencies by which lecanorin is converted into orcin, and, in fact, there is the same relation in regard to all general properties between erythrin and erythrin-bitter, as between lecanorin and orcin. This circumstance is of some importance, for, in order to arrive at a knowledge of the exact composition of such complex bodies as the coloring matters formed by the action of alkalies on these substances, and to understand perfectly the nature of the process by which they are produced, it is absolutely necessary to know the exact substance out of which each is in the last instance formed, the last link of the chain which precedes its formation.

Pseuderythrin.—For this substance it would be advisable to substitute another name, as, in this case, the substance by which it is accompanied is not erythrin but lecanorin. It is contained in very small quantities in the lichens that I examined. It is sparingly soluble in cold water, but easily soluble in boiling water, from which it crystalizes, on cooling, in shining plates and needles. If more of the substance is taken than the boiling water can dissolve, the part left undissolved melts and collects at the bottom of the fluid in oily drops, which, on the temperature falling a little below 212°, congeal, and form crystaline masses. This is a characteristic property of pseuderythrin, and one distinctly mentioned by Heeren. It is easily soluble in alcohol and ether, and also in alkaline solutions. It gives compounds with metallic oxides by double decomposition. When dissolved in ammonia, and exposed to the air, it gives, like lecanorin, a red coloring matter; but its conversion into the latter is much more slowly effected than that of lecanorin. When subjected to dry distillation, it also gives a crystaline sublimate, accompanied by a copious disengagement of gas. When its solution in an alkali is boiled, or left to stand, some time, it imparts carbonic acid to the alkali, the decomposition being accomplished, however, with much more difficulty than with lecanorin. The exact nature of the substance left in solu-

tion, after this decomposition, I was unable to determine, on account of the very small quantity of pseuderythrin which I had at my disposal.

The combustions which I made of this substance confirmed the formula established by Liebig, at the time of Heeren's investigation, viz., $C_{20}\ H_{12}\ O_8$.

The *fatty substance* mentioned above, I have examined but slightly. It is soluble in alcohol, but insoluble in ether and water. From an alcoholic solution it is deposited in small pearly-white scales; if the solution be spontaneously evaporated, it is obtained in small, hard, shining, transparent crystals. It is soluble in alkalies, forming soapy solutions, and is reprecipitated by acids. Its alkaline solutions do not become colored when exposed to the air. It cannot be melted without being decomposed. Ibid.

Iron Founding.—From the Glasgow Practical Mechanic and Engineer's Magazine.

(Continued frcm Vol. VI. Page 275.)

SECTION III.—ON DRY-SAND MOULDING.

The next branch of the subject which falls under consideration, is the manufacture of works in dry sand, usually called dry-sand moulding. This department embraces, generally, the manufacture of pipes, columns, shafts, and other long bodies of a cylindrical form, or approaching to it. Dried, or baked sand, as was formerly stated, consists of loam called pit sand, that has already been used in structures of loam work, mixed with fresh sand. Dry sand acquires a very firm and open consistence by the expulsion of its humidity by heat, and it is found to be much better adapted to the purposes above mentioned than green sand.

The mechanical part of the process of moulding in dry sand, is the same as in the case of green sand work. In general, no coal powder is mixed with this sand. When the mouldings are finished they are transferred to drying stoves, in which they are exposed twelve hours, or upwards, as occasion requires, to the action of a strong heat till their humidity is banished. The experience of the moulder must be his guide in so mixing the materials at his disposal, as to produce the most accurate form of mould when finished, which shall also be sufficiently porous. Such moulds permit a readier egress for the gases generated by the casting, than green sand; generally, also, the castings turned out are less vesicular, and smoother upon the surface.

When the castings are large, and especially if they are tall, the hydrostatic pressure of the metal upon the sides of the mould is counteracted, both by the firmness of the sand, and by the wedge-shaped form of the boxes. To aid the resistance, the sides are feathered along the outside, affording additional abutting surface for the sand. Fig. 1, is a view of one half of a moulding box for pipes, the other half being an exact counterpart. Fig. 2, is a cross section, showing parallel sides. Fig. 3, is a similar section of a wedge-shaped box for

heavier castings. It is formed with flanches along the sides, which meet those of the other box. By means of these flanches the two halves are bound together by glands. Fig. 4, is a cross section of a flanched rib. A pair of swivels is attached to the ends of each box, by which they are raised and inverted as occasion requires. Another pair is usually fixed on the middle of the sides, upon which, when the boxes are hung, they may turn in a direction perpendicular to the preceding, that they may be set vertically at their destined position, which is commonly in a pit dug to receive them.

Fig. 1.

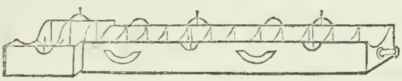


Fig. 2.

Fig. 3.

Fig. 4.

Pipe moulds are always either set upright on one end, or laid in a position very considerably inclined, on a bed of sand prepared for the boxes, at an angle of 30° or 40°. When practicable, the larger sizes of pipe moulds are placed in a vertical position, as well as all other comparatively tall articles; the general object being to raise all the slag that collects on the surface of the iron, while being poured, clear of the cast into the gate-way, securing thereby soundness to the cast. It is evident that, were pipes, for example, cast horizontally, the metal, at any given period in the running, would expose a large horizontal surface, which is unfavorable to the soundness of the casting, and impurities besides would infallibly lodge in the upper portion of the mould. Both of these objections are removed by setting the mould in an inclined, or a vertical, position.

In proceeding to describe the method of forming moulds for pipe castings it will be necessary, in the first place, to describe the construction, and the formation of the cores. In the constructing of pipe moulds, as well as the moulds of all other large hollow articles, it is necessary that the core be both rigid and porous; these conditions are obviously necessary, when it is remembered that the least flexibility in the core must alter the thickness of the casting; besides, that the core, being itself so much confined externally by the liquid metal when poured, the ends alone serving as channels of escape for the interior air, must offer within itself facilities for the escape of the gases generated. Both of these objects are accomplished by employing a tube of iron, forming the centre of the core, and perforated at regular distances for the escape of the air. For the smallest sizes of cores common gas pipes are used with holes drilled in them at about nine inches distance on alternate sides. Wrought-iron tubes of a larger size are employed for larger pipes; and, for the largest sizes, cast-iron pipes are adopted with rows of oblong holes cut at equal distances for ventilation. These cast-iron *core-bars*—the general appellation to all the varieties enumerated—have wrought-iron double knees fitted and bolted to their extremities for the purpose of sustaining journals, or bearings, upon which they may be turned on their own axes. The hollow ends of the wrought-iron pipes are formed square to receive

a winch by which they also may be made to turn upon themselves, the use of which operation will speedily appear.

Again, a core-bar for a pipe of any given inside diameter is selected, two or three inches less in diameter, with the view of providing for hay-rope and loam, by which the core is made up to the necessary thickness. The loam, which forms the external coat of the core, is made as open as practicable by augmenting the usual proportion of sharp sand in its composition. The hay also, which is simply twisted into ropes to facilitate its application to the core, fulfils the important office of a conducting medium for the air forced through the loam, leading it from all parts of the surface to the vent holes in the core-bar. The method of applying the hay and the loam is simple. The core-bar is rested, by its pivots, on two iron tresses, the upper edges of which are formed with corresponding semi-circular, or triangular, dentations, to receive the pivots. Thus placed, the core-bar is caused to revolve by a crank-handle applied at one extremity, during which operation the rope is led on regularly along the bar from end to end, and fastened there. It must be tightly done, as any slackness in the rope will permit it to yield when subjected to the pressure of the iron, which has the effect, at least, of altering the form of the pipe, if, as in some cases, it do not break up the core, and spoil the casting. Before finishing the core with loam, the hay receives a slight coating of it all over, as a cement to smooth down the surface. This being dried, for the succeeding application of the loam, a loam-board is necessary. This is a board of sufficient length to rest upon the tresses which support the core. Along this board is laid the loam intended to form the core. The edge of the board is cut exactly to the form of the core, being, indeed, a half skeleton reversed. This board being then set along side the bar, and weighted down at the extremities, at a distance of the half diameter of the pipe from the centre, it is evident, that as the core-bar revolves, and the loam is pushed over upon it, there will ultimately be formed a coating of loam completely enveloping the coat of hay, which shall also possess the figure of the core.

Fig. 5.

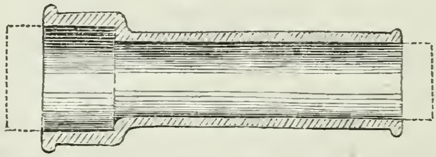
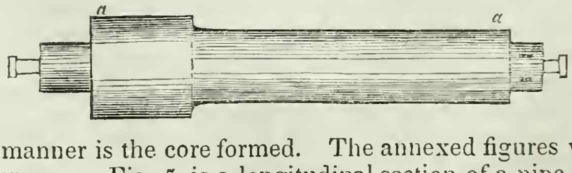


Fig. 6.



In this manner is the core formed. The annexed figures will illustrate the process. Fig. 5, is a longitudinal section of a pipe, in which

the exterior and interior outlines are represented. The dotted lines at each end indicate the additions necessary in the pattern as core-prints. Accordingly, fig. 6, represents the core as formed upon the bar before described, the core being prolonged to be supported in its bearings formed by the pattern, though it matters not if it should be longer than necessary. Fig. 7, represents the core-bar with its pivots at the ends, and the vent holes scattered over its surface. Fig. 8, shows the loam-board employed in constructing the core of the pipe, fig. 6. It will be observed to follow the outline of the core. Fig. 9, in like manner, represents the loam-board that would be required to form the pipe itself, fig. 5, were there no wood pattern of it. In such a case an additional coat of loam is run by means of it upon the core, fig. 6. In this way, it is evident, a loam pattern is at once formed.

Fig. 7.

Fig. 8.

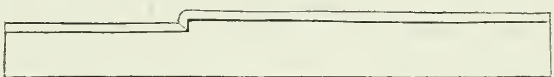


Fig. 9.

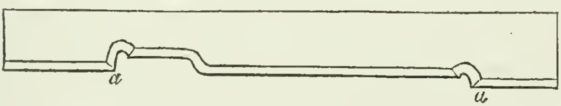
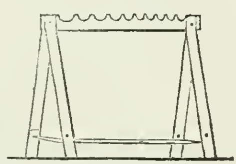


Fig. 10.

Fig. 11.



In setting the board, the parts *a*, *a*, (fig. 9,) will apply to the same parts, *a*, *a*, (fig. 6,) which, in so far, serve for a gauge. The misplacing of them exactly opposite each other, is to be guarded against, as there is not the same security for their being correctly placed. Before receiving, however, the additional thickness, the core must be washed over the surface with charcoal and water, that the thickness may be easily separable afterwards, and also thoroughly dried in the stove. In the mean time, having finished and dried the loam pattern, it receives, in like manner, a wash with charcoal water, and is ready to be moulded. This being done in the usual manner, the thickness is peeled off, and the naked core replaced in the mould. To aid the stiffness of the core, steeples are planted here and there over the surface of the mould, (as explained in the last article,) which resist any undue tendency of the core on one side, or another. Fig. 10, is a cross section of the body of the core. There are three concentric

pieces—the inmost, which is the core-bar, with several vent-holes in section, and the cross knee at the end; the next is the hay, and the external coat is the loam. Fig. 11, is a sketch of one of the iron tresses used in the work.

All wood patterns of pipes are constructed in two halves, which have two or more pins in the one entering corresponding recesses in the other, to prevent their shifting when put together and moulded. In proceeding to mould a pipe, a laying-down board is usually employed, which is simply a straight piece of wood as long and as wide as the moulding box. Upon this board one half of the pipe is laid with the flat side down, the box is placed over it, and rammed; the whole is inverted, and the board lifted off. The remaining half of the pipe is set upon the imbedded half, and the upper box over it, and linked to the under one; the upper box being rammed, the patterns are loosened, as we have in other parts described, and longitudinally also by blows upon the ends. The boxes being parted, the patterns removed, and the moulding black-washed with blackening, the core is set in, and the box closed. Small pipes, when there are several to be cast, are usually moulded in pairs in one box, when green sand is employed as a moulding material. The metal is poured in at one entrance, which branches to each moulding; shortly after which streams of aqueous vapor, mixed with hydrogen and other gases, arising from the imperfect combustion of the charcoal and hay, are expelled from the extremities of the core-bars, sometimes resolving themselves into luminous jets. Soon after the metal is poured, the castings are turned out to cool; after which the core-bars are drawn from them, which is a comparatively easy task, as the hay has been, for the most part, consumed, and, of course, occupies less bulk. Long small rods of iron are next introduced, with scrapers formed on the ends of them, and they are drawn from end to end, to clear the interior of the pipe of the remains of the core.

In the moulding of the various lengths of pipe that are required for use, one pattern is made to answer. Pipe patterns are generally made nine feet long, of which an appropriate number of lengths are cast, when more than nine feet of piping is required. But shorter lengths also are frequently wanted, when, of course, the full length of the pattern would not be proper. The moulding, therefore, is cut to the required length; in technical language, the pattern is cut in the sand. In such a case, some preparation is necessary to form a new bearing for the core. For this purpose two semi-circular pieces of wood, of the diameters of the mould, and the core, respectively, are sprigged together end to end, as in fig. 12; and it is obvious, that by placing the larger piece in the mould in each box, at corresponding parts, and ramming fresh sand about the smaller, the bearing will be formed. In like manner, if the piece of pipe terminate in a flanch the flanch having been moulded in its place, a half flanch of the same dimensions, with a half core print on it, as at fig. 13, is set into the mould, and the bearings for the core made up.

Fig. 12.

Fig. 13.

Small perpendicular branches required to be made upon pipes, are cast, either horizontally, or vertically, as may best suit the form of the box. In the latter case, the branch pattern is set loose upon the pipe, projecting upwards between the ribs of the box, and having been moulded, it is drawn out, and its core set in upon the pipe core, and the whole covered in.

Besides straight pipes, others have often to be cast of different forms, requiring peculiar treatment. In arrangements of pipe works, there is usually a number of knees, or bends, in their construction. These bends are usually cast separate from the straight portions of pipe, having facets upon them by which they may be afterwards joined to the pipes. The annexed, fig. 14, is a longitudinal section of a square knee in a line of pipes, showing the method of junction by spigot and facet. The term *spigot*, it may be as well to observe, is applied to the small semi-circular ring upon the plain end of a pipe, as may be seen in fig. 5; *facet* denominates the cup-mouth on the other end for receiving the spigot. There are usually patterns and core-boxes for pipe bends of the usual square-knee shape, in which case they are moulded in green sand. In the absence of patterns, however, for these, and for other varieties of short piping, they are *swept up* in loam, the core within the "thickness."

Fig. 14.

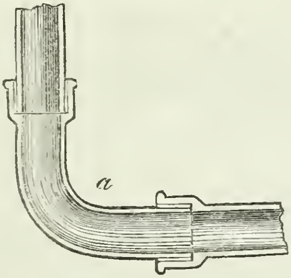
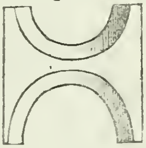


Fig. 15.



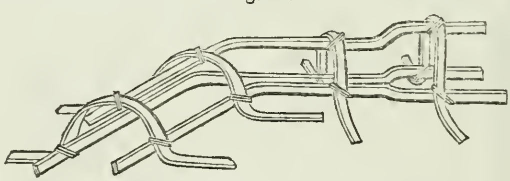
In this process, the first point is to have a level iron plate set, upon which the work is to be done. Like patterns, the loam work is formed in two halves. The cores are executed, in the first place, and, when dried, the thicknesses forming the exterior of the casting, are next laid on. Fig. 15, represents the gauge usually employed in forming small pipe work. As already said, the work is done in separate halves, for which purpose semi-circular cuts are made in the gauge, of which one is smaller than the other, being respectively the measures of the core, and of the additional thickness.

For example, suppose the bend, figured at sketch 14, is to be constructed, a small square rod of iron is bent to the form of the knee, against and along the side of which the gauge is moved. A quantity of loam being laid on the plate in the line of the pipe to be formed, the gauge in its progress fashioning the loam to its own form. When the two half cores are in this manner swept up, they are well dried and blackwashed, after which the gauge is inverted, and additional

loam being laid on for thickness, it is likewise shaped to the form of the pipe. The junction of the body of the pipe and the facet, which are of different diameters, and, of course, require different sweeps, is scraped out by a file when the loam is dried; the head on the end of the facet is either formed by a pattern applied to the moulding, or cut out of the *cope*.

The loam pattern being thus completed in two halves, dried, and blackened, it is bound together at two or three places by iron wire, and bedded half into a sufficient quantity of old loam mixed with water, and laid over the iron plate. The boundary of the loam is built up with fragments of cake loam. The bed being smoothed off on each side and dried, a layer of the same watered loam is applied to cover in the upper half of the pattern. As this upper layer has afterwards to be lifted whole, it requires to be strengthened by the addition of irons. With this view, pieces of rod iron, accommodated to the form of the moulding, are laid on among the wet loam transversely and longitudinally, and bound together by wires at the angles, constituting a kind of skeleton frame work, fig. 16, for the *cope*, as it is termed, or upper structure. The irons are then covered in with old loam, which is smoothed over them, and the whole is, for the last time, thoroughly dried.

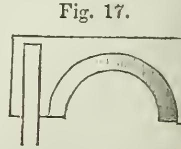
Fig. 16.



The building of the work being now completed, the next step is to undo it to clear out the thickness. The cope is lifted off carefully, leaving the rest of the work behind it, and this complete separation of the parts is one object for which the blackening, or charcoal, water is applied. In the same way the pattern is lifted out from the bed of the moulding. The thickness is easily broken off the core, leaving the latter entire; the halves of which are next bound by wire, and replaced in the mould, stayed by bearings at the ends, and by steeples intermediately. The cope is replaced, guided to its former situation by intentional irregularities on the junction surface, and is bound by wires laying hold of the skeleton, to the under plate.

The gate is formed in the usual manner by a pin stuck in the cope while being formed.

Fig. 17.



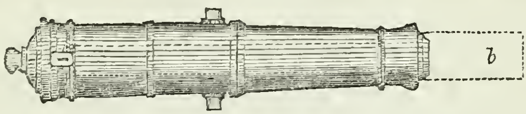
For some small pipes, such as bends which are uniformly circular, circular iron plates are frequently made to the same centre on both sides, so that when the cores are swept up on them, they lie concentric with each other. The edges of the plate will, therefore, serve for guides in the making of the core. For this purpose the gauges are made, as in fig. 17,

having a piece of wood nailed on, and projecting downwards. By sliding this gauge along the interior, or exterior, edge, as it may be adapted for them, the pipe is formed as before.

The manner of moulding and casting columns of every variety, and other long hollow work, is essentially the same as that now described for pipes; it is unnecessary to extend farther our details upon these articles. We shall conclude this section with a notice of the method of casting guns and carronades, taking, for example, a nine pounder gun, six and a half feet long, with a bore of 4.2 inches in diameter.

Fig. 18, is a representation of a nine pounder gun. Patterns made of wood may be employed where there exists no great demand for castings for them; but in the prospect of extensive supplies being expected to be furnished, it is a much superior method to construct iron patterns, which, when turned and polished in the lathe, always preserve their figure, and, of course, always produce good uniform castings.

Fig. 18.



As it is desirable to have these iron patterns as light as possible, consistent with the straining to which they may be subjected, they are made hollow throughout. It is then the business of the moulder, in the first place, to form a hay-and-loam pattern in a manner similar to that in which pipe patterns of loam are made.

As it is of great importance to secure solidity to gun castings, they are made without bore, and with an additional length on the muzzle end, as indicated by the dotted lines, which, of course, is provided for in the pattern. When the mould is formed, and set on end in readiness for being cast, the metal is poured into it slowly at first, increasing in flow as the mould is filled to the top, which is left open. Into this additional portion then, all the sullage rises that is collected during the course of the pouring, leaving the body of the gun casting generally in a pure state. The moulding sand adheres very firmly to the casting, and requires to be knocked off by a hammer and chisel afterwards in the course of dressing.

In preparing for boring the gun, the head, or sullage piece, is, in the first place, cut off close by the muzzle of the gun. A proper face is thus prepared for starting the bore, which is cut out of the solid.

It will be observed, on examination of the drawing, that the sullage piece is less in diameter than the rest of the casting. Formerly, lumps of metal of almost double the diameter of the muzzle were cast upon the end, in the belief that the exposure of such a considerable surface would draw up the sullage more readily to the upper part. This mode, notwithstanding the alleged advantages, defeated its own end; for it is easy to see that the body of the gun is opposed, by its taper, to the large head, being connected by the comparatively small muz-

zle. Accordingly, in course of cooling, as the shrinkage which attends the cooling, proceeds, the neck, or muzzle, will be forcibly drawn between the extremities, and will assume, in consequence, a vesicular structure, which is fatal to the perfection of the bore, and the strength of the metal. This cause of imperfection in gun castings vanishes in the comparatively small size of head now adopted, as it offers no opposition to the natural law of contraction, in connexion with decrease of temperature, while it, at the same time, affords free scope for the ascent of the sullage.

Our next step is to enter upon the business of *loam moulding.*

On the Process of Printing Warps to produce fabrics termed "Clouded," or "Chiné." By G. T. Kemp, Esq.

The art of clouding silk has been practiced upwards of a century, but until lately was conducted in a very rude manner, and at a very considerable cost.

The technical term to "cloud," or, as in French, "chiner," denotes the partial coloring of the threads of silk, or other material, previously to their being woven, producing an irregular, speckled appearance, or assuming a more definite design at the will of the operator, but always characterized by a softened, shaded, or irregular outline.

In 1839 a process, then in active operation at Lyons, was introduced into this country by Mr. Kemp, which afterwards proved to be nearly identical with that described in Mr. Walon's patent, taken out in 1825. In 1840, and following years, the process was very generally applied to manufactures of broad silks, ribands, shawls, and other articles of silk, as also to mixed fabrics of cotton, linen, or wool.

The process is as follows:—The warp, or "cane," generally of white, is "turned on," and "twisted in," in the ordinary manner, for introduction to a common loom, provided with a harness of the width and richness of the work to be manufactured. The "porry," or surface of silk stretched, or exposed, in the loom, is then carefully "picked," or cleared, from rough, or hairy, threads, and other imperfections. A firm heading, or "tab," about two inches in width, is first woven, after which a small rod is introduced in the shed, for the purpose of attaching the warp to the "cloth beam." "Cross-strings," are then woven in, to enable the workmen to twist the warp in with facility after being printed. The weaver next proceeds to draw about 12 inches of the cane through the harness, and weaves a strip of plain cloth, containing about 60 shoots, in three-fourths of an inch. After winding about 12 inches of the warp on the cloth beam, he repeats the strip of plain cloth, continuing the process, picking, or clearing, the cane throughout, until the whole warp has been thus prepared, the end of which he secures with a firm heading, as at the beginning. The shoot best fitted to weave in the strips of plain cloth is Italian singles, 12 or 14 deniers in size, with the usual Arganzine spin. This silk should be boiled off, allowing, by its fineness, the

coloring matter to penetrate the warp in printing. If a fine and delicate pattern is required, the interval of 12 inches cannot be exceeded with safety; but when the pattern is large, and the outline irregular, a longer space may be left between the strips. The cloth-beam, which needs not be more than three inches in diameter, requires a ring, or flanch, of wood, or cast-iron, to be fixed at each end of the warp to support the sides when it begins to rise on the beam, or roll. The frequent introduction of a set of smooth laths strung together, and encompassing, or casing, the beam, and wound on with the warp, are found to answer the same purpose as the flanches. It is important here to remark, that the warping and turning-on should be performed in the best manner, and the picking, or clearing, the cane very carefully watched, as it is obvious that mending any threads *after* the printing, must inevitably mar the work.

The object of forming the temporary fabric, just described, is to keep the threads of the warp in their proper positions during the subsequent operations of printing, steaming, washing, drying, and weaving, so as to preserve the pattern when woven.

The cloth beam with the warp thereon being delivered to the printer, he affixes it in a frame, in which it is supported horizontally on its axis; he then draws off a sufficient length of the partially woven warp, which is passed over the printing table, at the end of which it is attached to two parallel lengths of tape, about fifteen yards long, which pass over a series of rollers to an empty beam, which may be termed the printer's beam, to which they are attached, and which is placed near to, and *above*, the cloth beam, so as to enable the printer, at the same time, to let off the necessary length of warp from the cloth beam, and wind a corresponding length on to the printer's beam, as the printing of the warp proceeds.

When extended over the table, the warp is printed with blocks in the ordinary manner, as used by calico printers, being kept close down to the surface of the table, by means of a roller at each end, under which the warp passes, and which rollers are capable of being raised, or depressed, as circumstances require. The printing table is covered with a blanket, surmounted with an oiled, or painted, cover, between which and the warp a piece of calico is spread, of which a fresh length must be substituted every time a table-length of the warp has been printed. The neglect of this would cause the superfluous color, received by the calico, to smear the warp.

Each table-length of warp, when printed, is liberated from the table by raising the movable rollers, and is then drawn by the tapes over the series of rollers to the printer's beam, on which it is wound. During this passage of about fifteen yards in length, as before stated, a sufficient opportunity is given for *drying* the coloring matter on the warp, so as to prevent any smearing, or marking off, when rolled on the printer's beam. To assist the drying a certain degree of artificial heat with good ventilation is maintained.

The warp, thus printed, is wound off the printer's beam, and formed into a large skain of from eight to ten feet in circumference, and next undergoes the operation of *steaming* to fix the coloring matter,

great care being taken to prevent any condensation of moisture on the silk.

It is then thoroughly washed in a stream of cold water, to remove the extraneous coloring matter, and also the *thickening* ingredients with which the color is mixed. During washing, the silk is protected by a covering of loose canvas in which it is sewn up.

After drying, which is most advantageously effected without artificial heat, if the weather is favorable, the warp is given to the weaver to be rewoven into the ultimate figured cloth required.

In winding the warp again on the weaver's beam, the ordinary means of spreading it, by passing it through a coarse reed, or wraithe, are inapplicable, on account of the strips of cloth which have been woven across it; the process, however, is readily effected by stretching these strips to their full extent by hand, and thus guiding it on to the beam, or roll. The weaver pursues the ordinary method of manufacturing the piece of goods, drawing out as he proceeds in weaving the weft which has been woven in, to form the small strips of cloth before mentioned. No subsequent finish, or dressing, is required, and the work is ready for sale when it leaves the loom.

Trans. Soc. Arts, Manuf. & Com.

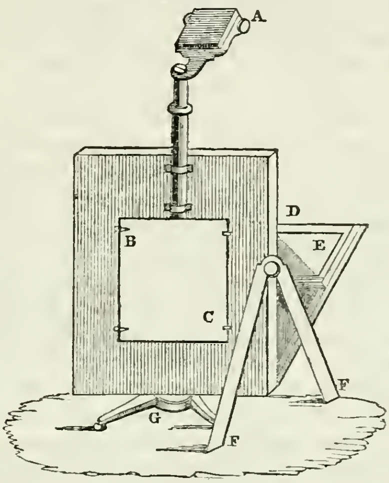
Smith's Prismatic Camera.

The Camera Lucida, though a very useful instrument, is open to this objection, that there is no image reflected upon the drawing paper; so that when any part of a sketch is left in an unfinished state, or the attention otherwise directed, it is next to impossible to commence again, so as to complete the drawing. To remedy this defect, Mr. Smith, the optician, has invented a very ingenious modification of the apparatus, which he calls the Prismatic Camera. It not only reflects on the paper a perfect outline of external objects, but preserves that outline without the least distortion, or alteration, of the portions for any length of time.

The construction of this improved camera is represented in the prefixed engraving.

In using the instrument, first open the stand G, always placing the widest of the three feet under the angular reflector, or silvered glass, D E, and the other two feet at the back. The reflector, D E, will find its own level, or position, when the machine is erect. Then steady the machine with the two wooden supports, F, and rule joint attached to the machine at the side. Adjust the prism A, to distinct vision, by sliding up or down in the tube. If a positive picture be required, it will be seen upon the slate, or semi-ground plate, of glass, B C. In this instance, the spectator should place himself between the object to be seen, and the machine, taking care that nothing intervenes between the prism A, and the object, always keeping the polished side of the square glass B C, towards the object. If a negative picture be required, the machine must be rendered opaque, by fixing with the four buttons the drawing papers. In this case, the spectator must sit with the machine before him.

Objects are seen to the best advantage when the machine is placed in a room with only one light, and that immediately opposite the machine. Should the picture, or reflected image, not be perfectly square upon the disk, this defect may be easily remedied by moving the machine, or the prism, (only) horizontally. By placing a print, or drawing, in an inverted position, and looking through the prism, it is seen erect, which answers all the purpose of the diagonal picture machine.



A, is a rectangular prismatic reflector; B C, a screen, or drawing board; D E, an angular reflector; F, the wooden supports; G, a tripedal stand.

Lond. Mech. Mag.

Mr. Defries' Dry Gas-Meter.

The description of this ingenious machine will be facilitated by comparing it with the double-acting steam engine, with which it is closely analogous, although the corresponding parts move with so little friction, that the trifling pressure of one or two pounds per square inch, thrown on the gas in the mains, is sufficient to move the entire apparatus; and the gas consumed is estimated by the number of movements of the expanding chambers of the meter, the cubical contents of which are known.

In the ordinary steam cylinder, with its slide-valve, the steam is admitted into the top of the cylinder during the time the steam at the bottom of the cylinder proceeds into the air, in high pressure engines, and into the condenser in those of lower pressure. When the slide-valve is moved, the conditions are reversed.

In Mr. Defries' dry gas-meter, the office of the cylinder is fulfilled by three rhomboidal cavities, each with a flexible diaphragm, which, by its bending, expands the one chamber, and contracts the other, in effect like the piston of the ordinary steam cylinder, and the meter is

provided with slide-valves and appropriate mechanism, which unites the three pairs of chambers into one system, so that the action is continuous and successive.

The external form of Mr. Defries' apparatus is that of a hexagonal prism placed on end; a horizontal diaphragm divides the hexagon into two principal parts, the lower and larger of which is subdivided into three rhomboidal compartments, meeting in the centre; each of these is bisected by a square, perpendicular, and *flexible* partition, formed of four triangular metal plates, hinged together at their edges by a skin of calf leather, properly prepared, somewhat as in the sides of organ-bellows. Attached to the centre of each flexible partition is a parallel motion, connected with a perpendicular shaft, which passes through a proper stuffing-box into the superior chamber, where the shaft terminates in an arm which communicates with a central crank; and as there are three such attachments, the expansion and contraction of the moving partitions communicate a rotary motion to the crank, without the necessity of a fly-wheel. Connected with the crank are three rods, moving the three pairs of slide-valves placed on an annular chamber, into which the gas first enters; the slide-valves lead it *into* those compartments which are expanding, and *out of* those which are contracting, into the general reservoir.

The pressure of gas on one side of the partition causes the contents of its fellow compartment to be discharged into the common chamber above, from which the measured gas passes direct to the burner. Below the crank of the central spindle, and upon the central axis, is fixed an endless screw, working in a vertical cog-wheel, communicating by a horizontal spindle with the index-train of wheels, by which the number of cubic feet of gas consumed in a given time is registered on a dial fixed outside the meter.

Trans. Soc. Arts, &c.

On a Screw-Joint for Water-Pipes, &c. By Mr. A. M. Perkins.

The mode employed for joining wrought-iron gas-pipes is to cut a right hand screw upon each extremity of every pipe, and to have corresponding sockets screwed at both ends with right hand threads, so that a socket having been screwed on the first pipe, the overhanging part of the socket serves for the reception of the second pipe, and so on. But the pipes do not come into contact.

Mr. Perkins, in his apparatus for warming buildings by a circulation of warm water, employs a right hand screw on the one end, and a left hand screw on the other end, of every pipe, and uses sockets which are tapped with a right and left hand thread at their opposite extremities.

Those ends of the pipe which are cut right hand are left square, whereas, those ends cut left hand are each formed as the frustrum of a cone, in other words, they have sharp, or V formed, edges. Therefore, when the differently formed extremities of two neighboring pipes are held at rest by means of gas tongs, and the socket alone is turned round, the pipes simultaneously enter the socket, and ultimately forci-

bly meet, so that the sharp edge of the one pipe is indented into the flat surface of the adjoining. The joints thus produced have been found capable of sustaining every pressure to which they have been applied, and the pipes themselves endure, without bursting, an expansive force of 3000 lbs. on the square inch.

The same principle is applied to cast-iron pipes for water-mains, &c., the right and left hand screws being cast on each pipe, and the sockets are also cast in iron. In these cases a mill-board annular washer, soaked in oil, is placed between the flat ends of the two pipes, which are screwed together by the double nut, as in the former case.

Ibid.

A New Gas.

The "Censeur," of Lyons, states, that at one of the late sittings of the municipal council, a trial was made of a new portable gas, to which its inventor has given the name of "hydroluminous." The apparatus, says this journal, is very simple, and applicable to the smallest candlesticks, as well as to the largest and most splendid candelabra. The light it gives is very fine, and it is so portable that it can be carried about with the common hand candlestick.

Lond. Mech. Mag.

Silver Plating as practiced at Sheffield. By Mr. Potter, Jr.

Plating on copper was first introduced in the year 1742, by Mr. Thomas Bolsover, a member of the Corporation of Cutlers, at Sheffield, who, when repairing a knife-handle, composed partly of silver, and partly of copper, suddenly thought that it might be possible so to unite the two metals as to form a cheap substance, which, presenting an exterior of silver, might be used for the manufacture of several articles hitherto made entirely of that metal. It was not till about forty years after the introduction of Mr. Bolsover's plan, that the ornamented parts of plated articles, called mountings, were constructed of silver. This great improvement caused the manufacture of plated wares to become one of the staple trades of Sheffield.

There are two important features in the process of silver plating, the one a perfect adhesion of the two metals, the other a protection from wear of the prominent edges by friction.

The process of manufacturing plated articles may be described as follows:—

An ingot of copper being cast, and the surfaces carefully prepared by filing, so as to remove all blemishes, and a piece of silver, also having one surface perfectly cleaned, are tied together by means of iron wire. A paste of borax and water is then passed round the edges with a quill, and the mass being placed in a common air furnace, is heated to a proper temperature, which is ascertained by means of a small aperture in the door. As soon as the union of the two bodies is effected, which is known by the oozing of the metal when the fusion of the two metals has taken place, the bar is removed from

the furnace. The quality of the silver used in this process is what is termed standard, containing about 18 dwts. of copper, to the pound troy. The effect of this alloy is to render the articles harder, and, consequently, more durable.

The ingot being thus prepared, the next operation is to form it into sheets, which is effected by passing the bar several times through large cylindrical rollers, generally moved by steam power; the lamination which the silver undergoes, during the operation of rolling, shows the perfect union of the two metals.

The dies for forming the ornamental parts of plated articles, consist of blocks of steel, on the face of which the pattern of the ornament is accurately drawn, after which the dies are moderately heated in an open fire, and then placed upon a leathern sand-bag; the die-sinker then proceeds to cut out the ornaments with hammer and chisel. When sunk to the proper depth, the surface of the sinking is dressed off, and prepared for the ornaments to be stamped in.

The stamping machine, of which a small working model was exhibited, consists of a vertical frame of iron, the uprights of which are formed with grooves in which the hammer, or drop, slides. The foundation of this machine consists of a square stone, on the upper surface of which is fixed an iron anvil, to which the uprights are firmly attached. The hammer is raised by a rope passing over a pulley fixed in the head-piece of the frame. The die is placed on the anvil immediately under the hammer, and kept in its proper position by screws. A luting of oil and clay is placed round the edge of the sink of the die, and melted lead is then poured into the cavity. When cool, the hammer is allowed to fall upon the lead, to which it firmly adheres by means of a plate roughed as a rasp, which is called the *lick-up*.

The silver used for the purpose of the mountings is also of standard quality, and is rolled to the required thickness; several pieces of the requisite size are then placed between pieces of copper of the same substance, and put upon the face of the die. The hammer is then raised, and allowed to fall gently upon them. This operation is continued for some time, gradually increasing the fall of the hammer, and diminishing the number of pieces struck, until they are forced to the bottom of the die; it is necessary occasionally to anneal the mountings.

The mounts being struck, as described, are now filled with solder, consisting of tin and lead, and afterwards secured by wires to the article to be ornamented, the body being covered with a mixture of glue and whiting, to prevent the solder from staining the surface; they are then soldered on by means of a gas blow-pipe.

The article is next boiled in a solution of pearl-ash, or soda, and scoured with fine Calais sand. The mounts are polished by a lathe, as in the case of silver articles, with rotten-stone and oil, then cleaned with whiting, and finished with rouge; a scratch-brush of brass wire is used for deadening the parts required, and the plain surfaces are burnished with tools of blood-stone, or steel, soap and water being used in this operation, which is performed by women.

Trans. Soc. Arts, Manuf., & Com.

On Mr. Williams' method of manufacturing Patent Felted Cloth. By J. Duncan, Esq.

The process of manufacturing cloth by felting alone, may be described as follows :—Supposing it to be required to make a carpet, 27 yards in length, and six quarters, or 54 inches wide, of coarse wool, and of stout substance. A carding engine, of the width of 80 inches, is, in this case, to be fed with about 45 pounds of wool. The wool having passed through, the card arrives at the last cylinder, from which the ordinary sliver is combed off, as usual, by the doffer. This sliver, which is very similar to a large and wide cobweb, is received upon an endless traveling web, also 80 inches wide, and about 37 yards in length, the carded wool overlaying it; and when the revolution, or journey, of 37 yards is accomplished, one sheet of sliver, 80 inches broad, is spread over the entire surface of the web; the operation having been repeated for about 20 times, or until the whole of the wool is thus combed, the layer, of 37 yards in length, and of about 20 slivers in thickness, forms what is called a bat of wool.

The bat is then cut, coiled on a roller, and carried to a machine, called the "Hardener," which consists of two, or more, pairs of rollers lying upon each other, and having perforated steam-pipes between them. The bat passes down between these rollers, being moved forward by their action, while the steam from the perforated pipes is driven into the wool, which is thereby heated and moistened at the same time; all the top rollers have a slight alternating motion, which rubs the bat slightly, and causes an entanglement of the fibre, and thus the felting commences. By the time the bat has passed once through these rollers it has become thinner, and of considerable texture and strength, from the locking together, and entanglement of the fibres; its second passage through the machine further improves its texture.

The next part of the process is to pass the hardened bat, or partly formed felt, through a machine, consisting of rollers in two tiers, each roller of the upper tier resting between two rollers of the under tier, the whole being immersed in a trough, or bath, of soap and water: and the upper rollers have the alternating motion already adverted to, as they first revolve—say an inch, and then retrogade half an inch, and so on.

The felt having been thus well pressed, and further advanced towards completion, may be said to be in a state comparable with that of woolen cloth made with threads by the loom in the ordinary way, and like it, it is carried to the fulling, or felting, mill, in which, after having been subjected to beating for eight hours, it becomes a firm cloth, and is ready for dyeing, or printing, as may be required, and, when tentered and pressed, is fit for the market. The felted cloth becomes reduced in the process to about two-thirds the size of the bale of wool, or from 37 yards long by 80 inches wide, to 27 yards long by 54 inches wide. Ibid.

Modes of determining the Velocity of the Piston of a Steam Engine at different points of the stroke.

At the last meeting of the British Association, Mr. J. Taylor described a contrivance for effecting this object, by Mr. A. Rous, who was formerly a working engineer in Cornwall. It consists of a half-second pendulum, having a pencil fixed upon it, and pointed against a card attached to the beam of the engine. By the motion of the engine, the card is moved perpendicularly, so that the pendulum being put in motion, the pencil marks upon it waved lines, which determine by their difference of width apart, the relative velocities of the piston at all its different points. They are wide apart when the piston moves quickly, and closer together as the velocity of the piston decreases, the distance between every two lines denoting the distance traveled through by the piston in half a second of time.

In connexion with this simple, ingenious, and efficient mode of attaining the end proposed, we may notice one of an opposite character which we find described and figured in the Tenth Annual Report of the Royal Polytechnic Society. It is the invention of the late Captain Richard Tregaskis, and was communicated to the Polytechnic Society in May, 1842. It consists essentially of a circular box, divided into a number of cells. This box is connected by a chain, with the beam of the engine, so that it (the box) shall perform a complete revolution for every stroke of the engine. This box is fitted into a frame, and directly over the cells are two* funnel-shaped caps, with a small hole in the bottom of each. These caps are filled with fine tin sand; and the quantity of the sand which will flow through the bottom orifices being determined, the apparatus may be applied to find the velocities of the piston in the following manner:—The sand funnels being adjusted, and the chain of the cell-box connected with the beam of the engine, as the box is turned horizontally on its centre at the rates of velocity corresponding with the varying velocities of the piston in the several parts of its stroke, each cell receives a portion of sand relatively proportionate to the velocity of that point. The quantities of sand in the cells being then carefully weighed, gives the velocity at all the corresponding points of the stroke.

This is illustrated in Mr. Fox's paper, by an account of two experiments with the instrument, by Captains Nance and Dunstan. Having ascertained, in the first place, that the funnel would discharge 17 grains of tin sand in a second, "the time-measurer" was connected with the engine, and so arranged that one of its divisions would pass under the funnel at every foot of the stroke of the piston in the cylinder. The quantity of sand discharged by one stroke of the engine, from the funnel, into each division, was then carefully weighed, and the thirds and fourths of time worked thus:—there being $5\frac{3}{4}$ in the first cell to find the corresponding time,

$$5\tfrac{3}{4} \text{ grains} \times 60 = 345, \text{ and } 345 \div 17 = 20'' \; 17'''.$$

* The report says *two*, and the drawings show *two* caps; we cannot, however, see reason why more than one is used. The contrivance appears to us to be quite clumsy enough in its best form, and two sand-caps only make bad worse.

In this way the time for every foot of stroke was computed, and is given in the following table:—

TRESAVEAN ENGINE. 12 feet stroke in the cylinder.				WEAL UNY ENGINE. 10 feet stroke.			
Feet.	Grains.	Time.		Feet.	Grains.	Time.	
1	5¾	20″	17‴	1	5½	19″	24‴
2	4	14	7	2	4	14	7
3	2¼	7	56	3	2	7	3
4	2¼	7	56	4	2	7	3
5	2¼	7	56	5	2	7	3
6	2¼	7	56	6	2	7	3
7	2½	8	49	7	2½	8	48
8	2¾	9	42	8	2¾	9	41
9	3¼	11	28	9	3	10	34
10	3½	12	21	10	8½	29	59
11	4½	15	53				
12	13	4	53				
	48¼	170	14		34½	120	45

It is hardly necessary to state that Captain Tregaskis' contrivance wants all the simplicity, accuracy, and convenience, which so markedly characterize that of Mr. Rous. It is, indeed, scarcely possible to imagine any modes of effecting the same end more opposite. That of Mr. Rous is not only ingenious, but we doubt not, will be found decidedly useful in conjunction with Watt's indicator; the other will, we are satisfied, never be again put in operation, unless it be by a novice who may wish to exercise himself in the niceties of manipulation.

Glasgow Mech. & Eng. Mag.

Wire Ropes.

This interesting species of cordage is fast superseding, in many situations, that formed of hemp.

Wire ropes were, more or less, used in the French navy so long as twenty years ago, and public attention being gradually directed to their utility, they were, about ten years since, introduced, to a very considerable extent, into the service of the mines in the interior of Germany, and since then their ascertained merits have rapidly worked their way forward into public confidence.

Soon after the passage of an act of Congress for the better regulation of steam navigation, which required, amongst other things, that metallic connections should be employed between the steering wheels and rudders of steamboats, several ingenious men turned their attention to the substitution of wire ropes, for the hempen cordage gener-

ally employed. A consequence of this was the manufacture of some very good wire cordage, or rope.

The methods of manufacture have been gradually improved until a wire rope is now made in which, without much impairing the initial strength of the wires, a degree of pliancy is retained amply sufficient for every practical object, and almost, if not quite, equal to that possessed by cordage of hemp laid up in the usual manner.

In England these wire ropes have recently been employed with the greatest success, in mine and railway use, and for the standing rigging of ships. They have received the public approbation of a large number of civil and mining engineers, amongst whom may be found some of the leading men, of these professions, in Great Britain.

The leading manufacturers of wire rope in England, at this time, are Messrs. Smith, and Newall, who have each procured patents for their respective processes. Wire ropes both flat and round, of Newall's manufacture, have been very highly approved, under various circumstances of use.

Thus, on the London and Blackwall Railway, *eleven miles* of this rope has been in constant use for two years. *Six miles* of wire rope on the Brandling Junction Railway, including an endless rope on an inclined plane 1000 yards long, is said to work very well. *Thirty-seven miles* of wire rope are in use upon the Durham and Sunderland Railway, and are stated by Mr. Blenkinsopp, the engineer, to have *treble* the duration of hemp ropes. On the Oldham incline of the Manchester and Leeds Railway, a wire rope has been working very satisfactorily for eighteen months. Upon the inclined planes of the Shrewsbury Canal, wire ropes have been at work for two years and a quarter, and Mr. Beech, the engineer, expresses his belief, *that they will last two years longer*, and he states, at the same time, that upon these planes the hemp ropes, formerly used, *never lasted more than two years*, whilst their cost was double that of the wire rope, and their weight four times as great! At the Gosport colliery, near Newcastle, *two flat wire ropes* have been in daily use for four months, without indicating the least wear, their weight, in proportion to hemp, being as 21 cwt. to 47 cwt. Mr. Rœbling, a civil engineer in this State, has directed his attention to wire ropes; he has manufactured some very good ones, and has written some interesting articles upon the subject.

The Canal Commissioners of Pennsylvania having become aware of the importance of employing wire ropes in the internal improvement service, have put some of them in use upon the State works crossing the Allegheny range, and in their recent report we find the following paragraph:—

Wire and Hempen Ropes.—The ropes for the inclined planes and ferries on the line of our improvements, have hitherto been an enormous annual expense to the State. They are made of hemp, and, upon an average, it is believed that they do not last more than one season. There are ten required for the planes on the Allegheny Portage Railroad, one for the Schuylkill plane, one for the Millerstown ferry, and one for each of the slips for hauling out section boats at Columbia,

Hollidaysburg, and Johnstown. The average cost of each of these ropes is about $ 2,333.00, requiring an aggregate yearly expenditure of $ 35,000.00 merely for cordage to do the work upon the main line of our improvements.

It has been an object with the Canal Commissioners to reduce this heavy expense, if at all practicable. For that purpose they ordered a wire rope for plane No. 3, of the Allegheny Portage Railroad last year, which was used a considerable portion of last season, and the whole of the present year, and which seems to have been but little injured by use during that period. Wire ropes also, but of a lighter size, have been procured for the slips for hauling out section boats at Johnstown, Hollidaysburg, and Columbia, one of which has been in use for two seasons, the other two have done the work for one season. A wire rope for plane No. 10, of the Portage Railroad, has also been ordered, which has been manufactured and delivered at that plane, and which will be put on it in the spring.

So far as these wire ropes have been tested, they bid fair to answer the purpose; and, if the experiment shall ultimately prove successful, a large annual saving will be made to the Commonwealth by their substitution for hempen ropes. COM. PUB.

Sylvester's Process for Repelling Moisture from External Walls.

We find in a recent number of the "Civil Engineer and Architect's Journal," an abstract of a paper on this subject, read before the Royal Institute of British Architects, by Mr. Benjamin Ferrey.

This paper describes a very successful application of the process referred to. It seems that in a very exposed part of Dorsetshire, there is a brick school-house, which, though built with heavy walls, and *battened* inside, was almost untenantable during the driving rains which occur in that quarter, in consequence of the water penetrating through, and trickling down the wall in streams. To the exterior of this building, Mr. Sylvester's process was carefully applied as follows:

"A sufficient quantity was prepared, by mixture, in the proportion of three-fourths of a pound of mottled soap, to one gallon of water; this composition, when in a boiling state, was laid over the surface of the brickwork, steadily and carefully, with a large flat brush, so as not to form a froth, or lather, on the surface. This wash was permitted to remain twenty-four hours to become dry and hard. Another mixture was then made in these proportions:—one-half pound of alum to four gallons of water, which after standing twelve hours, in order that the alum should be completely dissolved, was then applied in like manner, with a flat brush, over the coating of soap."

These operations were performed during dry weather, in the month of July, and the middle of summer ought always to be selected for the purpose.

"Within a month after applying the above process, there happened one of those tremendous south-west gales, accompanied by a heavy

driving rain, such as had formerly drenched the school-house, and obliged the inmates to put pails, cloths, &c., to catch the drippings inside. It is satisfactory to state that the walls were completely proof against the rain; not a drop penetrated through during forty-eight hours of the most severe weather, nor from that time (the summer of 1842,) to the present, though repeatedly subjected to like trials, have the walls admitted the least moisture, nor has the artificial coating suffered, apparently, the slightest injury.

"The liquids, when applied, form a complete thin scale, or gummy-looking integument, perceptible only on close inspection, and the rain splashes against the walls as against glass, and runs down the face in a similar manner."

In addition to the above, a block of very porous and friable sandstone, being wrought into a water-cistern, was well payed over, both outside and in, with Sylvester's composition, and then employed as a water-tank exposed to the open air, and all the vicissitudes of weather, *for three years, without receiving any injury*, though the particular stone used in this case, is notable for its inability to stand the weather without protection.

These facts—well authenticated as they are—induce us to request the particular attention of American builders to the very simple, and, apparently very useful, process of Mr. Sylvester.

Com. Pub.

Improvements in the Manufacture of Iron. By Thos. W. Booker, Esq., *of Melin Griffith, near Cardiff.*

The object of Mr. Booker's invention is to simplify and accelerate the conversion of cast-iron from its crude state into malleable, or wrought, iron, for which purpose the refinery, or furnace, is adapted to the various qualities, or descriptions, of cast, or pig, iron, which it may be necessary to use, by surrounding, or inclosing, the hearth with blocks of cast-iron, into, and through which, water is allowed to flow, or not, as may be expedient, and, as is well understood in making refinery furnaces, the blast of air being introduced through one, two, or more, apertures, or tuyeres, as usual.

The refinery is connected with the reverberatory, or puddling, furnace, which is constructed of the requisite form and dimensions. The bottom of the body of the furnace, and the grate bars, and binding plates and bars, are formed of iron: the other parts of the furnace are constructed with fire-bricks, sand-stone, or fire-clay, as is well understood. In the neck, or near the flue, of the reverberatory furnace, is an aperture through which the iron, when it has become decarburetted, or refined, in the refinery, is introduced, or run, in a fluid state direct from the refining hearth into the puddling, or reverberatory, furnace. On each side of which reverberatory furnace, a door is constructed; the door in the one side being immediately opposite to the door in the other, through which two doors the workmen perform the process of

puddling, in the ordinary way in which puddling is done, when working only with one door, which is the general practice.

As respects the refining.—Having thrown up the fuel, and having, by the application of fire and blast, produced the necessary heat, a charge of 9 cwt., or thereabouts, of pig, or cast, iron, of the description generally used for forge purposes, is thrown on and melted down, and decarburetted, or refined, in the ordinary way; and when the refining process is completed, the whole charge of metal is run off in a fluid state, direct into the reverberatory, or puddling, furnace previously prepared to receive it, by having been already heated to a proper degree of temperature, and by the bottom, sides, bridge, and opening to the flue, being protected in the ordinary way, by the workmen having previously thrown in a sufficient quantity of lime-stone and iron-cinder. The metal having been introduced into the reverberatory, or puddling, furnace in a fluid state, the workmen raise, apply, and regulate, and vary the heat in the ordinary way, by feeding and moving the fire in the grate, and raising, or lowering, the damper on the top of the stack, or flue, as circumstances require, and as is well understood; they, at the same time, stir and agitate the iron with bars and puddles, while the escape of the oxide of carbon, in a gaseous shape, takes place, and until the whole mass of iron agglutinates. The workmen then divide it into lumps, or balls, of a convenient size, and draw the charge from the furnace, passing the lumps to the squeezer, hammer, or rolling cylinders, or such other contrivance, or machinery, as is used for forging, or compressing, the iron.

During the process of refining the iron, by the application of heat and blast, in the open refining hearth, a considerable quantity of scoria, or cinder, is produced, which is tapped and run off as heretofore, as circumstances require; but it is to be observed, that during the process which the iron undergoes in the reverberatory, or puddling, furnace, the author does not find that any cinder need be generated, or produced, and cinders and lime-stones are thrown in, as already described, for the protection of the various parts of the furnace exposed to the action, or agitation, of the fluid metal, but no cinder need be tapped, or drawn off.

Mr. Aikin's opinion.—The principal novelty in Mr. Booker's invention, consists in placing the refining and the puddling furnace so near each other, that the refined iron may be run, in a liquid state, into the puddling furnace, instead of allowing it, as is usual, to cool, and become solid when let out of the refinery, previous to its being transferred to the puddling furnace. The heat lost by the iron is thus saved, as well as the time required to bring the solid, refined iron to a state of fusion.

If the quality of the iron produced by Mr. Booker's process, is not worse than that of iron refined and puddled in the usual method, Mr. B's. process deserves the approbation of the Society. But I would recommend that Sir J. Guest, or some other practical iron master, should be consulted.

Trans. Soc. Arts, Manuf. & Com.

Improved method of Bleaching Palm Oil. By CHARLES CAMERON, *Chemist.*

About six years ago a process for discharging the coloring matter of palm oil, was introduced into the soap manufactories here, which was as follows:—Into a strong cast-iron pan, built in the usual way, with a furnace below it, the manufacturers put two, or more, tons of oil, according to its capacity; they then, by means of the fire below, increased the temperature of the oil to 450°; the result was that the coloring matter was completely destroyed. But after working on it in the most careful manner, they were at last obliged to abandon it, for the following reasons:—

1st. By the time that the whole body of the oil was raised to 450°, the bottom of the boiler was heated to above 600°, and, consequently, the portion of oil in contact was decomposed, and, being converted into gas, frequently caused explosion to take place.

2nd. The effluvium from the decomposed portion was insufferable.

3rd. If not immediately run off, on the color being discharged, they frequently procured a black color, from the charred oil being mixed with the other.

The process was cheap, but from these reasons, and the danger attending it, they were obliged to relinquish it.

I have stated the above that you may the better understand the improvement I have effected in the process.

About four months ago I was induced to make some experiments to ascertain at what point of temperature the coloring matter began to give way, when I satisfactorily found that it began to change at 230°, and on continuing the process to within 2° or 3°, more or less, of that temperature, with *continued agitation*, it gradually lost its color, and at last became as white as home-made tallow, and of a hardness superior to any imported. I then fully established the fact, that a low temperature, (230°, instead of 450°,) length of time, and agitation, (agitation was not employed in the old process,) removed all the difficulties that prevented its former success.

The process which I recommend, and which is now acted upon here, may be thus described:—

A cast-iron pot is provided, containing from three to four tons of oil, with the ordinary furnace below it, and a horizontal, revolving fan of sheet-iron placed within it, for agitation, power being obtained from a steam engine with a speed of six revolutions per minute. In the absence of an engine, a wooden rake may be employed. The oil is then, by means of the fire, raised to a temperature of 230°; the fire is then withdrawn from below, and high pressure *steam* is introduced from a boiler, (15 lbs. pressure on the square inch of the valve) by means of leaden pipes, two, or more, according to the size of the boiler, of two inches diameter. By this means an equable temperature of 230° is obtained without any danger of decomposing the oil, and the process is continued until the color is completely gone. A vessel containing four tons will require ten hours to complete the

process, at an expense of only two or three cwt. of slack to each ton of oil.

It appears to me that the coloring matter is discharged by the absorption of oxygen from the atmosphere, as oil at a high temperature is known to have a strong affinity for oxygen at a high temperature, and hence agitation is essential, so as continually to present a new surface.

I inadvertently made it known, and although it is of great importance to the trade, I shall derive no benefit from it.

Ibid.

On Cutting Half-round, and other Curve-faced Files. By the late Sir John Robison, K.H., F.R.S.E., F.R.S.S.A.*

It is well known to workmen, that although it be an easy matter to get *flat-faced* files of almost any required degree of smoothness and regularity of surface, a *half-round* file having an approach to such smoothness, or regularity, is altogether unattainable at any cost.

A method having occurred to me of striking half-round, or even round, files with the same smoothness, and with nearly the same accuracy of figure, as the flat files, I beg leave to submit the process to the Society, that it may, through these means, become known to those to whom it may be of use.

To form a half-round file, either convex, or concave, I propose that blanks should be prepared as if for thin equaling-files, (*i.e.* of uniform thickness and breadth throughout,) and that they should be struck on one face, or both faces, of the degree of fineness required. This having been done, I propose that, by means of a screw-press, and swages of copper, or other soft metal, they should have the required degree of curvature impressed on them before being hardened, and that, in this manner, files with curved faces, but with the teeth of equable depth all across them, should be obtained.

In a similar manner I propose to form three-quarters round, or even cylindric, smooth files, by cutting flat blanks on one face, and then bending them on steel mandrils into a tubular form previous to hardening them.

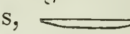
On communicating this plan to the eminent manufacturer, Mr. Stubbs, of Warrington, I learned from him that something of this kind had been attempted by his house, but abandoned on account of the difficulty experienced in getting the files into the curved shape after they were struck. Mr. Stubbs, at the same time, sent me a file so made, thirty years before. This file at once explained how the difficulty had arisen, as, instead of the blank having been made of uniform thickness and breadth, it has been fashioned like an ordinary crossing file, and, therefore, not susceptible of being squeezed into the regular curved shape by simple pressure. If Mr. Stubbs had thought of making the flat blank, he would, no doubt, have succeeded better;

* Read before the Royal Scottish Society of Arts, 12th December, 1842.

and the formation of tubular files, which he acknowledges never occurred to him, must have followed the other at a short interval.

Extract of a letter from Messrs. Johnson, Cammell & Co., Sheffield, to the late Sir John Robison, K.H., F.R.S.E., Nov. 7, 1843.

We now have the pleasure to hand you, as requested, an extract from our letter of Feb. 13th last, to the late Sir John Robison, explaining the mode we then adopted in the manufacture of the half-round files from steel of parallel thickness, as suggested by him, viz., by means of a screw-press, and swages of copper, and which we see is the plan named in the paper communicated to the Society.

From the specimens sent you last week, you will perceive we have deviated from the plan first suggested, "of cutting them from blanks of steel prepared as for a thin equaling-file." We, however, did not give up this plan until, from practical experience, we found its working very uncertain and irregular, for the file being of uniform thickness, the edges presented an equal, or greater, degree of resistance to pressure, than the centre; and the top swage, or boss, coming in contact with the centre of the file previous to any other part, caused it to bend more freely than the edges, producing various degrees of curvature in the same file. Again, if our top boss was so shaped as to create an earlier and freer pressure on the edges, to ensure a more uniform curve, we then endangered the sharpness of the teeth on those parts of each side of the file, convex and concave, first receiving such undue pressure. These objections and difficulties are all overcome, or lessened, by our present mode of cutting and turning the files from steel with slightly tapered edges on one side, thus,  The flat surface is cut with a continuous tooth, and can be turned either convex or concave, and the tapered surface can either be cut in ridges, or left *safe*, or uncut, which, from the following extract, you will perceive, was Sir John's first idea. In Sir John Robison's first communication, November 10, 1842, after recounting the difficulty of obtaining a smooth half-round file, or one of equal continuous tooth, he says:—

"I propose to overcome this difficulty, and to cut half-round files as truly smooth as flat ones are now struck, by making the blanks of rolled steel-plate; by striking them in the flat state, and by afterwards giving them the degree of curvature required, by means of a screw-press, and tin, or copper, swages; or else by passing them between grooved and furrowed rolls (of soft metal for the *struck side*)," evidently implying that one side would be unstruck, or uncut. In fact, for some time, at first we only attempted to cut one side of the file, and frequently now we are requested to leave sometimes the concave, and others the convex surface, blank, or uncut.

Edin. New Philos. Journ.

Elkington's Process of Electro-Plating and Gilding. By Mr. Pellatt.

It is immaterial what metal is used for articles to be plated by this

process; a compound metal composed principally of nickel, however, is preferred, which, when plated with silver, can scarcely be distinguished from the solid metal.

The first thing before plating, or gilding, is thoroughly to cleanse the articles from all grease, or oxide, and this is done by boiling them in caustic alkali, and scouring them with sand and dilute acid; they are then washed and dried, and a copper wire being attached to them, they are placed in a metallic solution of the metal required to be deposited, the wire being connected with the negative pole, while a silver plate, suspended in the same solution, is connected with the positive pole of the battery.

The process of gilding is similar to that of silvering, except that the gold solution requires to be heated while the process is proceeding.

Great care is required in the arrangement of the batteries, the object being to decompose the solution easily, and at the same time to produce a firm, smooth, and regular deposit of the metal. The secret of the manipulation consists in the correct balance of power between the battery, on the one hand, and the strength of the solutions, and the number of articles to be deposited on, on the other.

The solution for gilding is prepared by dissolving the gold in a mixture of pure nitric and muriatic acids, the product being a chloride of gold; after evaporation, this is converted, by means of an alkali, into the oxide, which oxide is dissolved in pure cyanide of potassium.

The solution of silver is prepared by dissolving pure silver in nitric acid diluted with distilled water, and similarly treated with the cyanide of potassium, as in the gold solution.

In forming articles of solid silver, the following process is employed:—

Upon a wax model is first deposited a copper surface by the electro-process; the wax is then melted out, and thus a perfect mould of copper is obtained, into which is deposited silver of any substance that may be required. The copper is then removed by dissolving it with acid, and the article required is obtained.

If the original model is in metal, an elastic mould made of glue and treacle is used, by pouring the composition, in a liquid state, upon the model.

By a late improvement the proprietors have the means of giving a metallic conducting medium to this composition, and to other substances, without the use of any external application, as black lead, &c.

Trans. Soc. Arts, Manuf. and Com.

Substitute for a Transit Instrument.

A neat reflecting instrument called a Dissleidoscope, has been contrived by Mr. Dent, the well known chronometer maker, to be used instead of a transit instrument, for determining the time by the passage of the sun and stars over the meridian of any place.

Imagine a prism made of three plane glasses so fixed, that the plane of the upper one is at right angles to the plane of the meridian,

but the upper end declining in any angle towards the north. When the sun, or star, as it approaches the meridian, comes into the field of this instrument, its rays are reflected in a given angle, from the surface of the upper glass. This angle is sensibly the same during the time the object is transiting the field of the instrument, and the image of the object will appear to travel from east to west.

A portion of the sun's light passing through the upper glass, will fall on the glass forming the eastern side of the prism, and being reflected thereon to the glass forming the western side of the prism, will be by that sent up through the upper glass. The consequence is, there will be two images of the sun, one reflected from the upper glass, and the other by two reflections from the lower glass. The last image, as the object approaches the meridian, and middle of the instrument, will travel from west to east, or directly opposite to the first reflected image; and when the object is on the meridian, the two images will coincide.

The angle in which the lower glasses are inclined to each other on the lower angle of the prism, is not necessarily confined to any limits, but it should not be too acute. The angle, however, in which the axis of the prism is inclined to the horizon, should be such as never to have the ray at right angles to it, or to the surface of the upper glass, because if it was the head, it would be in the way of viewing the contact, or coincidence, of the two images.

By putting the axis of the instrument parallel to the horizon, Mr. Dent has also contrived to make it an instrument of equal altitudes, and thus, with the aid of a good watch and clock, to determine its own meridian.

Mr. Dent generally places the axis of his prism parallel to the axis of the earth, but if that axis is made to move about another at right angles to the plane of the meridian, the transit of stars below, as well as above, the pole, might be observed. He also has the face of the prism, not—as we have for the better exemplification of the *modus operandi* described it—perpendicular to the plane of the meridian, but declining from it towards the west in a small angle. By this means he avoids the interception of the rays by the head.

The rectification and verification of the instrument are likewise very easy, and its trifling expense (two guineas) and portability, will, doubtless, render it a favorite substitute for the more costly transit instrument. It is, of course, a patented invention.

Lond. Railway Journ.

Gilding and Silvering by Immersion.

The following new methods of gilding and silvering, by immersion, have been adopted on the Continent. Their easy execution puts them within the reach of persons who have hitherto been strangers to this kind of operation:—

Gilding on Silver.—Silver is gilt very readily by means of neutral chloride of gold, added to a solution of sulpho-cyanide of potassium,

till the precipitate formed at first is redissolved. It is necessary that this liquid should preserve a slightly acid reaction, and if it has lost it by too great an addition of sulpho-cyanide, it must be rendered so by adding a few drops of hydro-chloride acid. In order to gild, the silver is plunged into this liquid nearly boiling, and tolerably concentrated, in which state it is kept by pouring, from time to time, some hot water to replace that which has evaporated. In this manner, inconveniences which would result from too great concentration of the acid is avoided, whose pressure is, nevertheless, useful to oppose the formation of an auriferous precipitate which takes place by elevation of temperature, when alkali predominates.

To Gild and Silver on Copper, Brass, and Bronze.—The solution of the cyanide of gold, or silver, has been already pointed out for silvering and gilding under the influence of electric forces, but it has been found that the same solutions, brought to a temperature near their point of ebullition, can also gild and silver by dipping. With regard to their preparation, if it were necessary to obtain them chemically pure, it would be expensive, without any advantage being obtained; the operation can be simplified, and rendered much less expensive, by adding directly, either to the chloride of gold, or to the nitrate of silver, neutral, the cyanide of potassium in excess, so as to obtain the soluble double cyanides.

Silver cannot be gilt by this method, but as has been already stated, the sulpho-cyanide of gold and potassium gilds this metal very well.

The solution of the cyanide of copper in the cyanide of potassium, will not copper silver, even in contact with zinc; however, it will copper this latter metal in a very solid and perfect manner.

It must, however, be stated that these processes, though so very convenient, because they always succeed, and require but a few minutes for their preparation, deposit, unfortunately, but a very thin coating of the precipitated metal. This is an inconvenience common to all methods of coating by simple immersion.

Civ. Eng. & Arch. Journ.

Hullmandel's Lithotint Process. By B. Rotch, Esq., V. P.

From the time of Senefelder, who invented lithography, in 1796, up to the present day, this beautiful art has gone on gradually improving; but in no instance has so important a step been made as in that of Mr. Hullmandel's process of producing original drawings, or fac-simile copies as may be required. Previously to the lithotint process being introduced, crayons made of a composition of grease, wax, shellac, soap, and black, were used for a similar purpose.

Mr. Hullmandel's process, which is the result of numerous experiments, may be thus described:—The drawing having been sketched, tinted, and finished by the artist on stone, with lithographic ink mixed with water, to produce the various shades, which is as easily done as on paper, is covered over with gum-water, and weak nitric acid to fix it. After remaining a sufficient time to dry, a solution of rosin in

spirits of wine, is poured over the stone, and as this ground contracts by drying, it cracks into thousands of reticulations, which can only be discovered by the use of a microscope. Very strong acid is then poured over the aquatint coating, which, entering all the fissures, produces the same effect on the stone as the granulations of the chalk by the ordinary process. The rosin protects the drawing in every part except in the cracks. The acid having remained a sufficient time to act on the unprotected parts of the drawing, is removed, the ground is washed off, and all appearance of the subject on the stone vanishes, until ink being applied by a roller in the ordinary way, it is reproduced, and ready for taking off the required number of impressions, which, in some cases, have extended to the number of 2000.

Trans. Soc. Arts, Manuf. and Com.

Lunar Occultations.

Lunar Occultations visible in Philadelphia during the month of April, 1844; computed by Mrs. Charlotte S. Downes, from the Elements published with the Occultation list of the United States Almanac.

The Immersions and Emersions are for Philadelphia, mean astronomical time. Im. for Immersion, Em. for Emersion. These abbreviations in *Italics* refer to those Immersions and Emersions which take place on the Moon's dark limb. N. App. for Near Approach.

The angles are for *inverted image*, or as seen in an astronomical telescope, and reckoned from the Moon's North point and from its Vertex around through East, South, West, to North and Vertex again. For direct vision add 180°.

APRIL, 1844.

Day.	H'r.	Min.	Star's name.			Mag.	From North.	From Vertex.
5	17	1	Im.	δ	Scorpii,	3	27°	11°
5	17	31	*Em.*				342	311
19	21	9	Im.		Mars,		32	87
19	21	58	Em.				299	354
20	6	13	*Im.*	κ^1	Tauri,	5.6	32	337
20	6	48	Em.				334	278
20	6	2	*Im.*	κ^2	Tauri,	6.7	62	5
20	7	3	Em.				304	249
20	7	59	*Im.*		Bessel,	8	119	66
20	8	52	Em.				248	197
21	7	35	*Im.*	*n*	Tauri,	5.6	159	103
21	8	7	Em.				218	163
22	7	4	*Im.*		Bessel,	8	104	50
22	8	15	Em				285	229
22	8	16	*Im.*		Bessel,	9	147	91
22	9	2	Em.				241	186
22	8	21	*Im.*		Bessel,	9	121	68
22	9	29	Em.				268	213
23	7	33	N. App.		Bessel.	9	☽N.4′.5	
23	10	4	N. App.		Bessel,	8	☽N.1′.9	
23	10	53	*Im.*		Bessel,	9	83	31
23	11	42	Em.				310	262
23	11	23	*Im.*		Bessel,	8	153	103
23	12	1	Em.				67	192
23	11	11	*Im.*		Bessel,	9	99	48
23	12	5	Em.				294	247
24	9	50	*Im.*	972	Bailey,	7	100	47
24	10	42	Em.				304	251

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE

State of Pennsylvania

AND

AMERICAN REPERTORY.

APRIL, 1844.

Civil Engineering.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Letter on Engineering. By Dr. Franklin.

The following letter on the improvement of the navigation of the river Schuylkill, written by Dr. Franklin, in London, in 1772, and addressed to S. Rhoads, Esq., of Philadelphia, the original of which is in the possession of a gentleman of this city, is a fine illustration of the sound, common sense, and far-seeing sagacity of that great philosopher, and is well worthy of a place in the Journal of the Institute which bears his name.

Since the days of Brindley and Smeaton, the fathers of British engineering, the improvements in hydraulic constructions, with the additional experience obtained in *slack-water navigations*, have made them, in many cases, preferable to canals, particularly for large boats, and in places where the preponderating trade is descending.

In twenty years, since the Schuylkill navigation was first opened. nearly eight millions of tons have been transported upon it; during the whole of which time it has been progressively improving, and adding more and more to the prosperity of Philadelphia.

S. W. R.

[Copy.]

London, August 22, 1772.

Dear Friend,—I think I before acknowledged your favor of February 29th; I have since received that of May 30th. I am glad my canal papers were agreeable to you. If any work of that kind is set on foot in America, I think it would be saving money to engage, by a handsome salary, an engineer from here, who has been accustomed

to such business. The many canals on foot here, under different great masters, are daily raising a number of pupils in the art, some of whom may want employ hereafter; and a single mistake through inexperience, in such important works, may cost much more than the expense of salary to an ingenious young man already well acquainted with both principles and practice. This the Irish have learnt at a dear rate, in the first attempt of their great canal, and now are endeavoring to get Smeaton to come and rectify their errors. With regard to your question, whether it is best to make the Schuylkill a part of the navigation to the back country, or whether the difficulty of that river, subject to all the inconveniences of floods, ice, &c., will not be greater than the expense of digging, locks, &c., I can only say, that here they look on the constant practicability of a navigation, allowing boats to pass and repass, at all times and seasons, without hindrance, to be a point of the greatest importance; and, therefore, they seldom, or ever, use a river where it can be avoided. Locks in rivers are subject to many more accidents than those in still-water canals; and the carrying away a few locks by freshes, or ice, not only creates a great expense, but interrupts business for a long time, till repairs are made, which may soon be destroyed again; and thus the carrying on a course of business, by such a navigation, be discouraged, as subject to frequent interruptions: the toll, too, must be higher to pay for such repairs. Rivers are ungovernable things, especially in hilly countries; canals are quiet, and very manageable: therefore, they are often carried on here by the sides of rivers, only on ground above the reach of floods, no other use being made of the rivers than to supply, occasionally, the waste of water in the canals.

I warmly wish success to every attempt for improvements of our dear country; and am, with sincere esteem,

Yours most affectionately,

B. Frankli[n]

S muel Rhoads, Esq.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On ascertaining, by inspection, the areas of Transverse Sections of Excavations and Embankments, with transverse ground slopes. By John C. Trautwine, C. E., & Arch.

The following method of ascertaining, *by inspection*, the areas of transverse sections of excavations and embankments, *with transverse ground slopes*, by means of a table of level cuttings, aided by diagrams, may sometimes be found convenient; it was devised by myself:—

Let *a b c d*, fig. 1, represent the transverse section of an excavation, or, by inversion, of an embankment, with a transverse ground slope, *a d;* and let *m n*, represent the depth of cutting, or filling, as generally taken by the level, at the centre *(n)* of the base, *b c*. As a preparatory step, lay a ruler parallel to *b c*, so as to make the triangle, *h a f*, as nearly as can be judged *by the eye*, equal to the triangle *h g d*,

and mark the points *f* and *g*. Then, to ascertain whether the two triangles be *really* equal to each other, lay a parallel ruler from *a* to *g*, and if, on transferring it to *f* and *d*, the line *a g*, is found to be parallel to the line *f d*, the two triangles *h a f*, and *h g d*, are equal to each other, because they both stand up on the same base *a g*, and are between the same parallels *a g*, and *f d*. But if the lines *a g*, and *f d*, are found not to be parallel to each other, the trial must be repeated until they become so. A few seconds will generally suffice for this process.

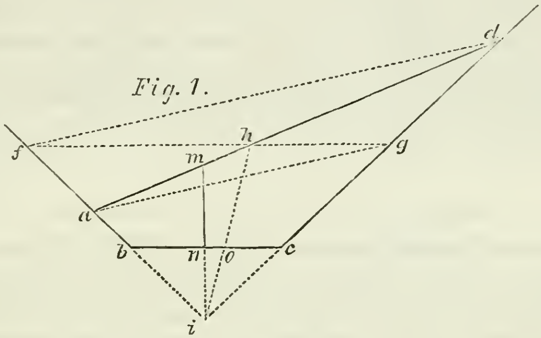


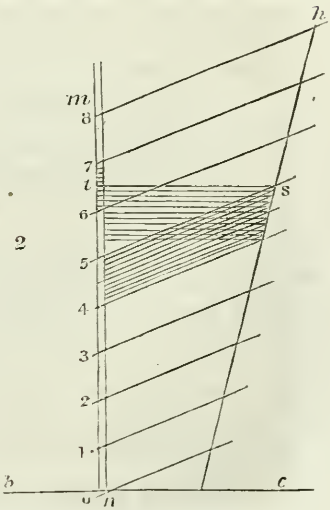
Fig. 1.

Having found the proper line, *f g*, draw a straight line from the point *h*, where it intersects the ground slope *a d*, to *i*, the point at which the side slopes meet, if continued. Then the portion *n o h m*, of the triangle *m h i*, prepared, as shown in fig. 2, will suffice for ascertaining, by inspection, aided by a table of level cuttings, the area of any transverse section having the same ground slope as *a d*, the same base *b c*, and the same inclination of side slopes *a b*, *c d*.

For example, if it be required to find the transverse area of a cutting 5 feet deep, having the ground slope represented in fig. 2, from 5 follow the line 5 *s*, and from *s*, the line *s t*. Then the area corresponding to the depth *o t*, taken from a table of level cuttings, will give the area required.

It may be objected that this empirical method does not admit of mathematical accuracy, which I grant; but the same objection applies to any other method that can be devised, from the fact that the measures and transverse slopes themselves are never taken with mathematical accuracy. It is plain that a series of triangles, such as fig. 2, prepared to a scale of one-fourth of an inch to a foot, and having different ground slopes, will admit of a determination of the depth to be taken from the table of level cutting to within,

2



at most, the tenth of a foot, which is as close as is ever aimed at in practice. It will apply equally to ground slopes which vary, or are irregular in themselves. Though, in this case, it is necessary to have a diagram representing an entire transverse section of the cutting, or embankment, by means of which the *average* slope must first be obtained, by first drawing a line to represent a ground slope, which will equalize the irregularities, and the slope of this line being ascertained, must be used in its appropriate triangular diagram. It would, of course, be necessary to prepare a separate series of triangles for different widths of base, and for different side slopes.

The principal advantages which I conceive to attach to this method, is that it dispenses entirely with calculation, and thus precludes much liability to error ; while, at the same time, it admits of great expedition. The principle of its demonstration is so evident, that I do not think it necessary to insert it.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On Long and Short Connecting-Rods. *By* T. W. Bakewell.

In the Journal of the Franklin Institute for Feb., p. 86, may be found an essay on "The relative efficiency of Long and Short Connecting-Rods, considered in the exposition of crank and connecting-rod motion." This paper is copied from a foreign periodical, the "Civil Engineer and Architect's Journal." It is well and imposingly written, and the position taken by the writer, H. F. Clifford, is supported by an overwhelming array of algebraic formula. It begins with—"The subject of the following paper is one of great importance to the practical mechanic, and as we have never yet seen any satisfactory solution of this long disputed question, we have endeavored to draw such conclusions from the investigation of the theory of crank and connecting-rod motion, as, we feel convinced, will set at rest all previous doubt concerning the comparative advantages of long and short connecting-rods."

The *drift* of the piece is to establish an inferiority in effect, or, in plain language, a "loss of power," in the shorter connecting-rod, owing to its greater angle with the direction of the piston-rod ; and that the forces transmitted through the rods L C, and S O, respectively, in their own directions, by any force in the direction of S L, are as the cosines.

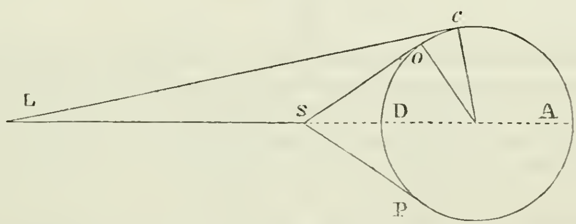
In the above it is, of course, intended that the cylinders be equal, and if the principle could be maintained, as stated, it would be perfectly practicable to construct an engine, worked with condensed air, and a long connecting-rod, which should pump back the used air into the receiver, through an equal cylinder and short connecting-rod, and leave an available surplus power.

Why is it that we set up our symbols against a law of nature, and seek to circumvent her, by a change in the proportions of our contrivances?

In a recent article in this Journal, bearing on another subject, the

following postulate is given: *the required intensity of resistance, to balance a given force, is proportional to the obliquity of that resistance to the given force.* This is true, and may be usefully impressed. It reverses the assumption of Mr. Clifford, and makes the transmitted forces through the connecting-rods, in their own directions, *inversely* as the cosines.

Let S P, be the short connecting-rod in its return, corresponding with its position at S O, and the piston-rod moving from S, towards D; then, by Mr. Clifford's theory, the force transmitted by the push, (thrust) through the connecting-rod, in its own direction, is decreased by the obliquity in the ratio of the cosines *directly*. But the arrangement of power and resistance is identical with what is called the "toggle joint press," acting downwards; and Mr. C. himself would admit, under this latter name, that the power moving in the direction of S to D, transmits, through the connecting-rod S P, in its own direction, a force increasing with the obliquity—in the ratio of the cosines *inversely*.



It must not be inferred that the above exhibit leads to a superiority in the short rod; the equality is shown in the completion of the act, and the greater efficiency near D, is but the compensation of what is withheld near A.

Cincinnati, 5th February, 1844.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

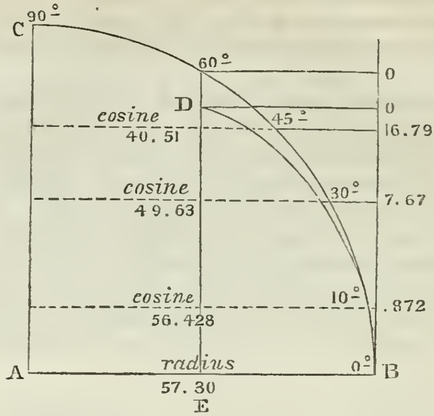
On finding Sine, Cosine, &c. *By* Thomas W. Bakewell.

Tables for finding the sine, cosine, &c., when accessible, supersede other means for that end; but where they are not, the following rule is offered, as obviating, without the aid of logarithms, an elaborate process.

The following reasoning leads to the rule: Let B C, be a quarter circle of 90 units long, which gives a radius of 57.30; let B D, be the half of a corresponding cycloid, of which E D, is the base, produced to the circle at 60°. D B, of the cycloid is equal to A B. 57.30 radius of the circle. The ordinates 0.0 to the circle and cycloid, are equal 38.65.

Now it is the property of the cycloid, that its ordinates are as the squares of the included portions of the curve from B, and if we nominally reduce the portion of the circle at 60°, to that of the cycloid, and call it 57.30, and make equivalent nominal reductions at other points

of the circle below 60°, it, the circular arc, will also have its ordinates at those points, as the squares of the included portions from B.



But the circle and the cycloid may be considered coincident from 0° to 17°, and as the octant of 0° to 45°, is sufficient to establish the sines, &c., of the quadrant, the remaining space of required reduction is from 17° to 45°, and through these 28 degrees the ratio of reduction is nearly direct and uniform. The immediate results of the rule, are the ordinates to the circle, as .872 –7.67– 16.79, which may be termed *supplements to the cosines;* and which, being known, we find, by familiar process, the cosine, sine, versed sine, and chord, and, more remotely, other geometric properties, growing out of the relation of the circle to a straight line.

The rule is not perfect, and in giving the multipliers, small errors and fractions have been compromised in such manner as to combine, as far as possible, brevity with accuracy; but at no one point does the error exceed $\frac{1}{3600}$th part of the radius.

Rule to find the supplement to cosine from 0° to 45°, where radius is 57.3. From 0° to 17°, multiply the square of the degree in question, by the decimal .00872.

Example for 10°.

$$10^2 = 100 \times .00872 = .872 \text{ sup. to cosine.}$$

From 17° to 45° deduct from said .00872 as often .0000152, as the degree in question is above 17°, and with the remainder multiply the square of said degree.

Example for 30°.

$$13 \times .0000152 = .0001976 \text{ for deduction,}$$
$$.00872 - .0001976 = .0085224 \text{ for multiplier,}$$
$$30^2 = 900 \times .0085224 = 7.67 \text{ supplement to cosine.}$$

Cincinnati, 20th Feb., 1844.

On the Efflux of Gaseous Fluids under Pressure. By CHARLES HOOD, ESQ., F.R.S., F.R.A.S., &c.*

The theoretical determination of the velocity with which gaseous fluids are discharged, through tubes and apertures, under pressure, has often been submitted to mathematical investigation; and the subject being of importance in various branches of practical science, it is to be regretted that considerable differences exist in the results of the several formulas which have been propounded for its elucidation. Dr. Papin,† in 1686, first showed that the efflux of all fluids follows a general law; and that the velocities are inversely as the square roots of the specific gravities. Dr. Gregory‡ has likewise given various formulæ for calculating the velocities of air in motion, under different circumstances: and Mr. Davies Gilbert,‖ Mr. Sylvester,§ Mr. Tredgold,¶ and many other writers of equal authority, have also investigated the subject.

The hydrodynamic law of spouting fluids, has, by all writers, been applied in the calculations for the determination of this question. This law, it is well known, is the same as that of the accelerating velocity of falling bodies; and is proportional to the square root of the height of the superincumbent column of homogenous fluid. But although the various writers all agree in this fundamental principle, they differ materially in the modes of applying it, and in the several corrections introduced into their theorems; and the results they have arrived at are of a very contradictory character.

Dr. Gregory's formula for calculating the velocity with which air of the natural density will rush into a place containing rarer air, is based upon the velocity with which air flows into a vacuum. This is equal to the velocity a heavy body would acquire by falling freely from a height equal to that which homogeneous atmosphere would have, whose weight is equal to 30 inches of mercury. The height of this homogeneous atmosphere is 27,818 feet; and the velocity which a body would acquire by falling from this height (and, consequently, the velocity with which air will flow into a vacuum,) is $\sqrt{(27.818 \times 64.36)} = 1339$ feet per second. The density of the rarified air, divided by the density of the natural atmosphere, and this number, subtracted from unity, represents the force which produces motion; and the square root of this number multiplied by 1339 ft. (the velocity with which air rushes into a vacuum,) is the velocity with which the atmosphere will rush into any place containing rarer air.**

The method employed by Mr. Davies Gilbert, is also based upon the velocity with which air rushes into a vacuum, when pressed by a homogeneous atmosphere, equal to the weight of the natural atmosphere at the earth's surface. This supposed homogeneous atmosphere, is, according to Mr. Davies Gilbert's calculation, 26,058 feet; and the velocity with which air would rush into a vacuum when pressed

* Read before the Institution of Civil Engineers; and communicated by the author.

† Philosophical Transactions, 1686. ‡ Gregory's Mechanics, vol. i, p. 513. ‖ Quarterly Journal of Science, vol. xiii, p. 143. § Annals of Philosophy, vol. xix, p. 408. ¶ Tredgold on Warming Buildings, p. 76. ** Gregory's Mechanics, vol. i, p. 515.

by this weight, will be $\sqrt{(26{,}058)} \times 8 = 1295$ feet per second. When this calculation is applied to two columns of air of unequal density—as, for instance, the discharge of air through a chimney shaft—the height of the heated column of air, divided by the height of this homogeneous atmosphere, and the square root of this number multiplied by the velocity with which air flows into a vacuum, and this product again multiplied by the square root of the numbers representing the expansion of the heated air, will give the velocity in feet per second. The expansion of air, when heated, is found, according to Mr. Gilbert, by raising the decimal 1.002083, which represents a volume of air expanded by 1° of Fahrenheit, to the power whose index is the number of degrees which the temperature of the air is raised; or, it is equal to the fraction $\overline{\frac{481}{480}}\Big|^{n}$ n, being the number of degrees of Fahrenheit which the temperature of the ascending columns exceeds that of the external atmosphere.*

Mr. Sylvester's method of calculation proceeds upon the supposition that the respective columns of light and heavy air represent two unequal weights suspended by a cord, hanging over a pulley; and this mode of calculation gives a result very much less than by any other method.

The unequal weight of two columns of air is found by Mr. Sylvester in the same manner as by Mr. Gilbert. The volume of air expanded by 1° of heat, is equal to 1.00208; and this number, when raised to the power whose index is the excess of temperature of the heated column, gives the expanded volume of the air: and assuming the atmospheric density to be unity, we have

$$1 - \left(\frac{1}{1.00208}\right) e = d;$$

e, being the excess of temperature of the heated column, and d, the difference of density between the two columns. This difference of density multiplied by eight times the square root of the height of the tube, or shaft, containing the heated air, gives the velocity in feet† per second.

In Mr. Tredgold's theorum for calculating the efflux of air, the force which produces motion is assumed to be the difference in weight of a column of external, and one of internal air, when the bases and heights are the same. The difference of temperature of the two columns, by Fahrenheit's scale, divided by the constant number 450 *plus*, the temperature of the heated column, and this quotient multiplied by the height of the tube, or shaft, gives the difference in weight. Then, by the common theorum for falling bodies, eight times the square root of this number will give the velocity in feet per second; or accurately

$$V = \sqrt{\frac{64\frac{1}{3}\, h\, (t - x)}{450 + t}},$$

* Quarterly Journal of Science, vol. xiii, p. 113. † Annals of Philosophy, vol. xix, p. 408.

h being the height of the tube, t the temperature of the internal, and x the temperature of the external air.*

The method of calculations proposed by Montgolfier, appears, however, by recent experiments, to be the most accurate, as it is also the most simple of all the modes of determining this question. The difference in height must be ascertained which two columns of air would assume when the one is heated to the given temperature, the other being the temperature of the external air; and the rate of efflux is equal to the velocity that a heavy body would acquire by falling freely through the difference of height.

The space which a gravitating body will pass through in one second, we know to be 16.09 feet; but by the principle of accelerating forces, the velocity of a falling body at the end of any given time is equal to twice the space through which it has passed in that time, or the velocity is equal to the square root of the height of the fall, multiplied by the square root of 64.36 feet; or, again, to the square root of the number obtained by multiplying 64.36 feet by the height of the fall in feet.

When the *vis viva* is the difference in weight between two columns of air, caused by the expansion of one of these columns by heat, the decimal .00208, which represents the expansion of air by 1° of Fahr., must be multiplied by the number of degrees the temperature is raised, and this product again by the height of the heated column. Thus if the height of the column is 50 feet, and the increase of temperature 20°, we shall have $20 \times .00208 \times 50 = 2.08$ feet; or 52.08 feet of hot air will balance 50 feet of the cold air; and the velocity of efflux of the heated column when pressed by the greater weight of the colder column, will be equal to $\sqrt{(2.08 \times 64)} = 11.55$ feet per second.†

The efflux of air under any given pressure can also be calculated by the same means. For the pressure being known it is only necessary to calculate the height of a column of air which would be equal in weight to this pressure. Thus, if the pressure be equal to one inch of mercury, water is 827 times the weight of air, and mercury 13.5 times the weight of water; therefore, $827 \times 13.5 = 11164$ inches, or 930.3 feet: and, according to the preceding formula, $\sqrt{(930.3 \times 64)} = 244$ feet per second, for the velocity of efflux under this pressure of one inch of mercury.

In all these cases the velocity thus ascertained is independent of any loss by friction. A certain deduction must be made for this loss, which will vary greatly, according to the nature and size of the tube, or shaft, through which the air passes, as well as with the velocity of the air. Like all other fluids, the retardation of the air, by friction, in passing through straight tubes of any kind, will be *directly* as the length of the tube, and the square of the velocity; and *inversely* as

* Tredgold on Warming Buildings, p. 76.

† This, which is the usual mode of calculating the expansion of air, differs considerably from that already given, employed by Mr. Davies Gilbert, and Mr. Sylvester; and also from the formula of Dr. Gregory. The calculation of the latter is based on the expression $(1.376)^{\frac{x}{180}} = V$, x being the required temperature, and V the volume at that temperature.—*Gregory's Mechanics*, vol. i, p. 486.

the diameter. This question, however, becomes very complicated under these circumstances, and particularly so when there are angular turns in the tube through which the air passes. The present state of our knowledge on this subject does not allow of any very accurate determination of the amount which ought to be deducted for friction from the initial velocity obtained by calculation; and it is only by empirical means we can arrive at an estimate of its amount.

We shall proceed now to ascertain how far these theoretical calculations agree with the results obtained by experiments.

In some new furnaces which Sir John Guest has lately added to his extensive iron works at Dowlais, some experiments have been made on the quantity of blast injected into the furnaces. In these experiments the machinery employed being new, and of the best construction, the loss occasioned by the escape of air through imperfections of the apparatus, was, perhaps, as small as possible. The engine for blowing the furnaces, made, at the time of the experiments, eighteen double strokes per minute. The diameter of the blowing cylinder was 100 inches, and the effective length of the stroke 7 feet 6 inches. From these dimensions, therefore, it appears that 14,726 cubic feet of air was taken into the blowing cylinder per minute; and the tubes through which it was discharged from the receiver, were six of 4 inches diameter, and six of $1\frac{1}{4}$ inch diameter: the area of all these tubes was, therefore, .5747 of a square foot, and the pressure of the blast, measured by a mercurial gauge, was equal to $4\frac{1}{2}$ inches of mercury. Calculating by the formula already given, we shall have $\sqrt{(827 \times 13.58 \times 4.5 \div 12 \times 64)} = 519.2$ feet, which is the velocity per second; and this number multiplied by 60, and then by the area of the tubes, will give $519.2 \times 60 \times .5747 = 17903$ cubic feet of air discharged per minute. From this amount some deduction must be made for friction. The velocity of the discharged air is 354 miles per hour; and with this immense velocity, and through such small pipes, the friction is, no doubt, considerable. By deducting 18 per cent. from the calculated amount of 17,903 cubic feet, we shall have 14,681 cubic feet, which agrees within a fraction (namely 45 feet) with the quantity obtained by measurement.

In other experiments made at the same place, the following were the results:

The quantity of air which entered the blowing cylinder was the same as before, namely, 14,726 cubic feet; the total area of the tubes which discharged the blast was .5502 of a square foot, and the pressure of the blast was equal to four inches of mercury. The calculation, therefore, will be $\sqrt{(827 \times 13.58 \times 4 \div 12 \times 64)} = 489.5$ feet per second: and, therefore, $489.5 \times 60 \times .5502 = 16.159$ cubic feet discharged per minute. The velocity of the blast, in this case, was 333 miles per hour; and if we deduct for friction 9 per cent. from the calculated amount, the remainder is exactly the quantity of air which is ascertained, by experiment, to be discharged through the tubes.

In a work published in 1834, by M. Dufrenoy, being a report to the Director General of Mines, in France, on the use of the hot-blast in the manufacture of iron in England, the results are given of many

similar experiments to the above; but, with two exceptions, the details are not sufficiently ample to found any calculations upon. The two exceptions named are the furnaces at the Clyde, and at the Butterley Iron Works, when they were blown with cold air. Both these blowing machines are described as having been in use for several years; and it is, therefore, natural to suppose the various parts were more worn, and fitted less accurately than in those experiments already described. The experiments were also made with less care. They show a different result to those already detailed; as in these the calculated quantity of air appears to be less than the quantity which entered the blowing cylinders in about the same proportion as it exceeded it in the former cases. The difference, no doubt, arises from the imperfect fitting of the piston of the blowing cylinder, which, by allowing a portion of air to escape, would diminish the apparent pressure on the mercurial gauge placed at the further extremity of the apparatus, and thence the calculated rate of efflux would, of course, be diminished.

In the experiments at the Clyde Works, the quantity of air which was discharged into the furnace, when estimated by the quantity that entered the blowing cylinder, was 2827 cubic feet per minute. The pressure of the blast was equal to six inches of mercury, and the area of the tubes .0681 of a cubic foot. Calculating the discharge of air under this pressure, it amounts to 2450 cubic feet, being 13 per cent. less than the measured amount, supposing no loss to occur by imperfect fitting of the apparatus.

At the Butterley Works the quantity of air discharged into the furnace, estimated by the contents of the cylinder, was 2500 cubic feet per minute. The pressure of the blast was equal to five inches of mercury, and the area of the tubes .0681 of a cubic foot. The quantity, by calculation, appears to be 2235 cubic feet, being less by 10½ per cent. than that shown by experiment. In both these last cases, however, there is but little doubt that the loss of air from the cylinder caused the pressure on the mercurial gauge to be less than it would have been, had the apparatus been perfectly tight; and a very small diminution in the observed height of the mercury would account for a much greater difference in the velocity of efflux than is here shown.

We are fully warranted in the conclusion, from these experiments, that this method of calculation is as accurate as any theoretical determination of such a question can be; but, from the results so obtained, an allowance must always be made for friction, which will necessarily vary with the peculiar circumstances of each case.

The following table will exhibit the results of the preceding experiments at one view:—

TABLE I.

Place and Number of Experiments.	Pressure of blast in inches of mercury.	Area of tubes, (square feet.)	Velocity of blast, (miles p. hour.)	Quantity of air by experiment, (cubic feet.)	Quantity of air by calculation. (cubic feet.)	Difference in quantity, (per cent.)
Dowlais, No. 1,	4.5	.5747	354	14726	17903	+ 18
Do. No. 2,	4.0	.5502	333	14726	16159	+ 9
Clyde, No. 3,	6.0	.0681	408	2827	2450	— 13
Butterley, No. 4,	5.0	.0681	372	2500	2235	— 10.5

In order to show the results of the several modes of calculation which different mathematicians have adopted, the following table has been calculated from the data given in experiment 2 of the preceding table; and it shows how far the several modes differ from each other in their results:—

TABLE II.

Place of experiment.	Pressure of blast in inches of mercury.	Area of tubes, in square feet	Quantity of air by experiment.	Quantity of Air Discharged (by calculation.)				
				Montgolfier.	Gregory.	Gilbert.	Sylvester.	Tredgold.
Dowlais,	4.	.5502	14,726	16,159	15,152	14,855	5,017	15,555

Considering the amount of friction which must result from the discharge of air, at the immense velocity which was obtained in this experiment—viz., 333 miles per hour—and also that some of the tubes were only $1\frac{1}{4}$ inch diameter, it would probably be considered that the highest of these calculations is the nearest the truth, as it only allows of a reduction of 9 per cent. being made for friction to reduce the calculated amount to the quantity obtained by experiments. It may, therefore, be concluded, that the method which gives this result is the most accurate, as it is also the most simple, for general use.

Lond. Mining Journ.

Description of the new Dock Gates at Grangemouth, on the Forth. By James Thomson, Esq., C. E., Glasgow.

Mr. Thomson exhibited a model and drawings of the dock gates recently constructed at Grangemouth, where the entrance lock, upon which are four pairs of gates, is 250 feet long, 55 feet wide, with a depth of 25 feet water over the sill into the new wet docks. The gates, which are wholly built of timber, consist of a double framework, the front framing, or that next the sill, being straight, and the back curved, both, of course, uniting together in the heel and meter posts. The back, or curved framing, is formed with arched ribs, composed of plank in three thicknesses of four inches, firmly bolted together, and to the corresponding front ribs; this double framework, being braced together with horizontal. and diagonal, tension rods of iron, is planked on both sides, and made perfectly water-tight. The gates constructed in this manner are extremely light and buoyant; and by the admission of more, or less, water, with additional balance weights. the buoyancy of the gate is so adjusted, that its whole weight is borne by the water, and, consequently, very little power required for opening and shutting, besides the great saving in tear and wear, thus reduced to a minimum; in proof of which it was stated, that instead of from ten to twelve minutes, with four men, the time and power usually required for opening, or shutting, gates of similar dimensions, these gates, by means of improved crab gearing, are opened, or shut, in three and a half minutes, with only two men; and with a longer allowance of time, even one man is able to work them. Thanks voted, and given from the chair.—*Trans. Roy. Scot. Soc.*

Civ. Eng. & Arch. Journ.

Observations upon Iron Lattice Bridges. By James Thomson, Esq., C. E., Glasgow.

Mr. Thomson illustrated his observations with numerous drawings and models of several lattice bridges already completed, or at present carrying into execution, by Mr. Macneill and himself. The principle of lattice bridges, applied in timber, has, for some time back, been in use in America; but the adaptation of the principle to iron bridges. as now so successfully applied by Mr. Macneill and Mr. Thomson, is likely to supersede, in a great degree, the use of timber, and will supply a desideratum hitherto felt in establishing internal lines of communication, &c , where the expense of stone bridges not unfrequently precludes their being carried into effect, while the objection to wooden structures, on the score of durability, is obviated by the substitution of iron. The first bridge of this kind, recently completed by Mr. Macneill, on the line of the Dublin and Drogheda Railway, and of which drawings were exhibited, is 85 feet in span, consisting of two lattice-work frames, or beams, one on each side, resting upon stone abutments; the lattice-work beams are composed of small bars of malleable iron, about 12 feet long, and only a quarter of an inch thick, placed

so as to cross each other at right angles, and forming a net, or lattice-work, riveted at every intersection; the lattice frames, so constructed, and stiffened with angle iron, support the roadway by means of light transverse beams, also of malleable iron, secured to the lattice-work at each end. This bridge, which altogether weighs only fourteen tons, sustained a load across its centre of twenty-four tons, under which the deflection amounted only to 3-10ths of an inch.* A viaduct 230 feet in length, with a central span of 140 feet, is now being constructed by Mr. Macneill, over the Royal Canal in Ireland, for heavy locomotive traffic. This viaduct, of which Mr. Thomson exhibited drawings, has a third lattice frame in the centre, and is composed of malleable iron bars half an inch thick. Mr. Thomson described a very useful application of this principle to the widening of the roadways of existing bridges; and exhibited a prettily constructed model of one of the arches of a stone bridge, about 400 feet long, with the addition of footpaths on each side, as at present executing under his direction, the old width of roadway being only 17 feet, while, with the new footpaths, supported by iron lattice-work, the width will be increased to 30 feet. The appearance of these bridges, which may be either perfectly straight, or slightly curved, as circumstances require, is light and graceful, combining, as they do, great strength with the least possible quantity of materials, and seem to be admirably adapted for crossing wide and deep valleys, rivers, &c., at a small expense, as also for ornamental bridges in parks, or approaches to gentlemen's seats, &c. The expense of construction, Mr. Thomson estimates at less than half the cost of stone; but he stated that he was at present making an investigation into their principle, with experiments upon a different arrangement of the lattice-bars, which he hoped would lead to a considerable saving, both in the quantity of material and workmanship.—*Trans. Roy. Scot. Soc.* Ibid.

Description of a Cast-Iron Bridge over the Avon, near Tewkesbury, on the line of the Birmingham and Gloucester Railway. By Capt. W. S. Moorsom.

The principal novelty of this work, which was proposed, and its execution superintended, by Mr. Ward, of Falmouth, is the mode of constructing the two piers, which were externally of cast-iron, in the form of caissons, each weighing about twenty-eight tons; the plates composing each caisson were put together on a platform erected upon piles over the site of the pier: the bottom of the river being leveled by a scoop-dredger, the caisson was lowered, and, some clay being thrown around the exterior, a joint was formed, so nearly water-tight, that two small pumps drained it in six hours. The foundation being then excavated to the requisite depth, the caisson, which sank as the excavation proceeded, was filled with concrete and masonry; cap plates were then fixed for supporting eight pillars, with an entablature,

* The cost of this bridge, including the stone abutments, was £510; the lattice bars are $2\frac{1}{2} \times \frac{5}{8}$, the lattice frames 10 feet deep, and the floor line is $5\frac{1}{2}$ feet above the bottom.

to which was attached one end of the segmental arches, 57 feet span, with a versed sine of five feet two inches. There were three of these arches, each formed of six ribs of cast-iron, and two such piers as have been described, the land abutments being of stone work, joining the embankment of the railway. It was stated that this mode of construction was found to be more economical, in that peculiar situation, than the usual method of fixing timber coffer-dams, and building the piers within them, the total cost of the bridge being only 10,192*l.*, and the navigation of the river was not interrupted during the progress of the work. The paper was illustrated by eighteen drawings by Mr. Butterton.—*Trans. Inst. C. E.*

Lond. Athenæum.

The Screw Propeller—Steam Navigation.

At the last meeting of the Liverpool Polytechnic Society, the president, John Grantham, Esq., C. E., in the course of his annual address, said, that finding that he had but few observations to make on the state and prospects of the Society—so even had been the tenor of its way through all the changing scenes of the times—he should introduce to their notice a topic of public interest, suited to the character of their meetings: the subject he alluded to was the present state of steam navigation. After some introductory observations, as to the failure of the science as a profitable mercantile speculation, he called their attention to the screw propeller, as a substitute for paddle-wheels—an improvement which he had great hopes would do much to place steam navigation on a firmer foundation. Several short notices of the screw propeller had appeared in scientific publications, [see *Mining Journal* of the 28th October, for a detailed description, with diagram,] but they were very imperfect, and little could be gleaned from them. It had, however, been referred to more satisfactorily, in a paper written by Mr. Elijah Galloway, the patentee of paddle-wheels, in an appendix to Tredgold's work on the steam engine. But the author had not formed a decided opinion on the question, and did not establish its superiority. The French claimed to be the original inventors of the screw propeller, and few would dispute with them the honor on this point—though they also claimed the steam engine, which was due to the English. The lecturer here referred to a French paper detailing the performances of the French war steamer *Napoleon*, which were certainly satisfactory, and next noticed a number of instances in which the screw had been employed, even from the year 1699. It was also tried by different parties in 1743 and 1763. In 1802, the *Doncaster* transport, which had been becalmed, was worked into harbor, at Malta, at the rate of one and a half mile per hour, by eight men at a spell. She went seven leagues with a screw, and the parties seemed to have contemplated every kind of propeller since patented by others. In 1825, the screw was applied to a vessel in the Thames. In 1828, a patent was taken out for a screw by Mr. Charles Cummerow. In 1832, M. Sauvage also

applied it. In the same year, Mr. Woodcroft, of Manchester, took out his patent; in 1836, Mr. Smith his; and in 1838, Mr. Ericsson also obtained one. Cummerow's and Smith's were much alike. Mr. Grantham then explained the principle of the screw, or inclined plane, and its advantages over the paddle-wheel, assuming, for argument's sake, that simply as a propeller, there was no preference to be given to either. He referred to cross sections of two vessels of the same dimensions, one with the paddles, and the other with the screw; also to longitudinal sections of the same. By pointing to these, he clearly showed the several advantages of screw vessels. There were several kinds of screw propellers, but the principle was the same in all—an inclined plane turned round a spindle, or cylinder. (This he showed by wrapping a piece of paper, in the form of a right angled triangle, round a roller; and the hypotenuse, or slanting edge, of the paper, described the worm of the screw, which might be made of any pitch.) And if a screw were made to revolve in a solid, by giving it one revolution, it would move forward, or backward, a distance equal to the pitch. There might be several threads in the same screw, but although this constituted a difference in form, the principle remained unaltered. Mr. Smith's first experiments were made with a single thread, or incline, wound round an axis, making an entire revolution, and presenting to the eye, when looking in the direction of the axis, the form of a complete disk. Ericsson's, and others, consisted of a short portion of the screw, with many threads, or inclines, in some cases appearing to the eye when placed in the direction of the axis, as a complete disk. (He here described the number of blades on the screw, and how they were formed.) Woodcroft, who obtained his patent in 1832, adopted a slightly different system. Instead of the thread being uniform, and the incline the same at all points, he proposed an increasing pitch at the after end. His object would be understood by considering a fish's tail, more particularly that of the eel. In the evolutions made by its body and tail, they each continued to increase; and, consequently, the rapidity with which it struck the water increased also, and compensated for the loss of effect occasioned to the tail by the motion given to the water by the body. In like manner, by giving this constantly increasing angle to the screw, the same result would follow. This he (Mr. Grantham) conceived to be a very beautiful modification of the original screw propeller. The principle did not escape the attention of others; and it was to be regretted that it had not been tried earlier, and made known. He had alluded to the plans of Messrs. Smith, Ericsson, and Woodcroft, to the first two as being best known, and because he believed the award of superiority, was, by almost common consent, given to it. Mr. Smith was the originator of a company that built the *Archimedes*—a vessel that circumnavigated England, and performed other long voyages. She first drew public attention to the subject. Great credit was due to that spirited company, and to Mr. Smith, for these experiments, which were conducted on a liberal scale; but this was not the first vessel that had been propelled by a screw. Ericsson had previously done much, and displayed great originality of thought. The form of his

propeller, although not the subject of this patent, had never yet been surpassed, and it required only the elongated pitch to make it the most efficient yet constructed. He, the lecturer, was influenced by this opinion, when recently called upon to construct the small vessel called the *Liverpool Screw,* which had been at work on the Mersey. He had taken care not to infringe any patent on the screw he adopted, and was surprised to find, on looking over the list, that these valuable plans had been overlooked. Several experiments had been made by Messrs. Brunel, Claxton, and Guppy, at Bristol, under the superintendence of the latter, upon various forms of screw in the *Archimedes.* In these some curious facts were observed, and it was then suggested that it was possible to propel a vessel faster by the screw, than the screw itself would have gone, had it worked in a solid medium. He at first conceived that there was an error in the calculations, but subsequent observation induced him to believe it possible to obtain such a result, and that all vessels having the screw in the dead wood, or run, have a tendency to go faster than the theoretical calculation would lead us to expect—though if this tendency were increased, it would be at a loss of power. He accounted for it by the manner in which water fell into the vacancy left as the vessel passed onward. A similar operation might be observed in watching the eddy formed by the pier of a bridge, in which case the body was stationary, and the water moved, but their relative positions were the same in both. The conclusion, therefore, was, that though the relative effect between the screw and the vessel appeared to be favorable, yet that being obtained at a great sacrifice of power, such a result might arise from defects in the form of the vessel, and was, therefore, no good indication, and that the utmost efficiency would be obtained, when the speed of the screw was from one-fifteenth to one-twentieth part greater than that of the vessel. The lecturer then noticed some of the most remarkable screw vessels that had yet appeared, and the forms of the propellers employed, and considered the difficulties that opposed the general introduction of the screw, and showed that some of the objections to it were groundless. He showed, by diagrams of two vessels of equal size, that where paddle-wheel vessels could not easily have any beams over the engine room, on the plane of the lower deck, as the engine, &c., rose to the deck above, beams might be introduced in screw vessels at that point, not only greatly strengthening the vessel where she most wanted it, but admitting of a clear range of saloons, or cabins, fore and aft, with little, or no, interruption.

A short, interesting discussion took place, in the course of which the chairman ably and convincingly replied to the questions propounded, on the supposed lateral pressure of the screw.

Mining Journal.

English Patents.

Information relative to the process and cost of procuring Letters Patent within the British Dominions. From the circular of Newton & Son, *Patent Agents, London.*

The United Kingdom of Great Britain and Ireland, is, as far as regards patents for inventions, divided into three distinct countries, for each of which separate patents must be obtained by any inventor who wishes to protect his invention throughout the whole of the British Dominions; but a patent for either country alone may be obtained without reference to the other two. All British patents are granted for the term of fourteen years; and the expense of obtaining them, as well as the time required to pass the papers through the different offices, varies in some slight degree, according to the time of year at which the application is made.

The average, or *ordinary*, cost of patents for England and Wales, Ireland, and Scotland, if unopposed, and passed in the ordinary manner, without extra fees, but including the agent's commission, is as follows:—

For England and Wales, about		£ 110
Scotland,	do.	82
Ireland,	do.	134*

If no opposition is entered against the delivery of these patents, they may be generally obtained in about three weeks, or a month.

In order to protect an invention in the British colonies and possessions, including the channel islands of Jersey, Guernsey, Alderney, Sark, and Man, the inventor must signify his intention to that effect at the time of petitioning for his English patent; and this extension of the patent right will increase the expense of an English patent about £ 5, thereby making it cost altogether about £ 115. The attention of patentees is particularly directed to this point, as, in the event of the English patent being granted without including the colonies, the inventor must apply for a new patent for the latter alone, at an expense nearly equal to the original cost of the English patent. Any person, or persons, whether British subjects, or foreigners, may, if resident in the United Kingdom, obtain a patent for any invention that is new in the British Dominions; and no difference whatever, either in the cost of a patent, or the amount of protection it affords, is made between British subjects and foreigners, and no peculiar restrictions are imposed on the latter, as is the case in many foreign countries. The previous publication and use of an invention abroad will not invalidate a patent obtained subsequently in the United Kingdom, provided the invention is new in this country at the date of the patent.

* By a recent act, whereby the stamp duties in Ireland were assimilated to those in England, the cost of an Irish patent was increased £ 10, thereby making it the amount stated above. Before the passing of this act, the stamp duty on an Irish patent was £ 20, but the stamp on an English patent being £ 30, that on the Irish now becomes the same.

In applying for a patent, the inventor, or applicant, is not required to give any *detailed* description of the invention, or improvements; he has merely to sign a declaration in the presence of a Master in Chancery,* affirming that he has invented, or is in possession of, an invention for something, such, for example, as "*certain improvements in steam engines;*" and that the invention is not known, or in use, within these kingdoms to the best of his knowledge and belief. This declaration is accompanied by a petition to the queen, setting forth the same thing, and praying that her majesty will be pleased to grant him Letters Patent for the said invention. Upon this two-fold document being deposited in the proper offices, every person having a caveat at all bearing upon the invention, is immediately informed that an application has been made, by certain parties, for a patent in England, Scotland, or Ireland, as the case may be, for "*certain improvements in steam engines;*" that if they consider that the said invention will interfere with the subject of their caveat, and desire to oppose the grant, an opposition must be entered within seven days from the date thereof, otherwise the patent will proceed.

If no opposition is entered, the patent will be granted in the course of a few days; but if the proprietor of some caveat, imagining that the application will interfere with his invention, should enter an opposition, the Attorney, or Solicitor, General will appoint some day, generally about a week in advance, when he will hear both parties separately, and in private, and examine their inventions, so as to determine whether the two inventions clash; and if, upon examination, the Attorney, or Solicitor, General, shall decide that the two inventions are alike, the grant of a patent will be refused to either party, until some amicable arrangement is entered into, as to their mutual interests; but if the inventions are found to be dissimilar, the patent is allowed to proceed, upon condition that the petitioner deposits a description of the main features of his invention with the Attorney, or Solicitor, General, by whom it is officially sealed up, until the enrolment of the petitioner's specification: after which time any person can procure an office copy of the deposited document, including the drawings, if any, at a moderate expense; and if the enrolled specification is not found to agree, in the main points, with the description deposited with the Attorney, or Solicitor, General, the patent may be attacked at law, upon the ground of fraud upon the Crown, as the patent is granted upon the report of the law officers of the Crown, for the invention described in the deposited document, and for nothing more that is really, substantially, and essentially different. It must not, however, be considered, that the patentee is tied literally to the description which he has deposited, and is, therefore, precluded from making any trivial alterations, or improvements, upon his invention; it is merely intended to be a check upon dishonest persons, and prevent such a one from availing himself of another party's improve-

* In London there is a proper office in which these declarations are made, but in the country almost every solicitor is empowered to witness the signature of this and other documents having reference to any business in Chancery, consequently there is no necessity for the personal attendance of the inventor in London.

ments, and, in fact, specifying an invention altogether different from that for which his patent was granted.

It may be here remarked that as the opposing parties are heard separately in a private room, neither can become acquainted with the particulars of the other's invention. The costs attending an opposition fall equally upon the applicant and his opponent, each party paying the official fee of £3 10*s.*; and in order to prevent vexatious opposition, the latter is called upon to pay his costs at the time of entering his opposition, and the former pays for the hearing when the meeting takes place. If there are two, or more, oppositions against one patent, they are all heard seriatim at the same sitting, and a separate official fee, of the above amount, must be paid for each opposition; the applicant, however, only pays one fee for the hearing, whether there be but one, or fifty, oppositions.

A caveat is a memorandum, inscribed upon the books of the offices through which all patents must pass, calling upon the clerks to give notice to the proprietor thereof, of every application that is made for a patent having any reference to the subject for which the caveat is entered. This caveat remains in force twelve months, costs £1 1*s.*, and may be renewed annually.* Caveats are sometimes entered for particular manufactures, or trades, such as spinning, weaving, candle, or soap, making, purifying oils, &c., by persons engaged, or interested, in those particular branches of trade, merely for the purpose of being informed of all the improvements that are taking place, but without any ulterior intention of opposing any particular application, or obtaining a patent themselves.

Patents may be, and sometimes are, opposed at a subsequent stage, when the proprietor of a caveat has, from some cause, neglected to enter his opposition at the proper office; but when this is the case, the oppositionist must enter what is called a special caveat: he is further obliged to pay the costs on both sides, and also defray any expenses that the petitioner may have incurred since the time that the opposition ought to have been entered in the regular manner. This, however, is of rare occurrence, as the opposing party is obliged to deposit the sum of £30 in the hands of the Attorney General, in order to meet the costs of the opposition, and the extra expenses above mentioned; and if the opposition is successful, the whole of the £30 is forfeited; but if the patent is still allowed to proceed, the balance, after deducting the Attorney General's fees, is paid back again to the opposing party.

Although, as was before stated, a complete specification of the invention is not absolutely necessary, upon making application for a patent, yet, when an inventor, *residing abroad*, is desirous of obtaining British patents, he should furnish the agent with a complete and detailed description of the invention, accompanied by correct drawings, if necessary. For the full protection of the inventor's interest,

* As the nature and object of a caveat is not well understood by inventors generally, it may be as well to observe, that it is a private document, and gives no kind of priority, as has been erroneously supposed, neither does it form any part of the progress of a patent, and is not essentially connected therewith. It is merely a precautionary measure, whereby immediate notice is obtained of interfering applications.

this description ought to be, in every way, as complete as if he were applying for a patent in his own country; as in the event of any opposition being made by parties in this country having the same object in view, the agent may then be enabled to remove such obstacles to the grant of the patent. From what has been stated as to the nature and use of a caveat, it will be seen, that it is perfectly useless for any inventor, residing more than three days' post from London, to take this step alone, as the time allowed for entering an opposition against any conflicting claim, would expire long before an answer to the notice could be returned.

The most politic course for an inventor to pursue, in the event of his having some invention, or improvements, which he may ultimately wish to protect by patent in the United Kingdom, but of the success of which he is not perfectly certain, is to take the preliminary steps to secure a patent for England, and make the application in the regular manner, as if it were his intention to obtain the patent in due course. This step, which would not cost more than £10, if unopposed, and forms part of the ultimate expense of the patent, would carry his application past the stage where oppositions usually occur. Having arrived at this stage, the application may be suspended for a while, until the inventor has had an opportunity of *privately* testing his improvements; and when convinced of the value, and probable success of his invention, he may then proceed to complete the patent. It must, however, be borne in mind, that taking this preliminary step will not entitle the patentee to publicly make, use, or sell his invention, as any exposure of this kind, before the patent is actually sealed, will endanger its validity; his experimental trials, therefore, must be strictly *private.* It is also advisable not to expose the invention to view before the sealing of the patent, as such a public exhibition would be unnecessarily dangerous, and might as well be avoided.

When an application for a patent is made by more than one person, the expense is materially increased, an extra fee being charged at several of the offices for every additional name, amounting in the whole to about £20 extra for the second name, and a further sum of nearly the same amount for every additional name.

The documents on which the grant is founded having been duly passed through all the proper offices, the patent is eventually sealed, by the Lord Chancellor, with the Great Seal of England, in the case of an English patent; and, for this purpose, certain days, called "*public seal days*," are appointed by his lordship, and on those days *only* can patents be sealed, except by payment of an extra fee, which, if the Lord Chancellor happens to be in town, will not exceed £2; but if, as is often the case during the vacation, his lordship should be out of town, a further expense is incurred for a journey to his lordship, according to the distance he resides from London. When patents are, in this manner, sealed on other than the appointed days, they are passed by what is termed a "*private seal.*"

The mode of procedure, in making applications for Irish and Scotch patents, is similar to that above described in reference to English patents; but Irish patents are sealed by the Irish Lord Chancellor,

with the Great Seal of Ireland; and Scotch patents with the seal appointed by the Treaty of Union, to be used in place of the Great Seal of Scotland.

The exclusive right to use, or dispose of, the invention, is vested in the patentee from the day on which the patent is sealed, and he, or his licencees, without endangering the validity of the patent in the slightest degree, and prior to the enrolment of the specification, can immediately make, use, or sell, his invention, or the produce thereof; and any person using the same, or vending articles resembling the invention, or purporting to be produced thereby, without licence, or consent, from the patentee, becomes liable to an action for infringement.

To save the trouble, loss of time, and expense of a journey to England, foreigners can obtain patents in the United Kingdom, for their inventions, in the name of any friend who is a resident in this country; or, if preferred, inventions may be patented, as is often the case, in the name of an agent, as a communication from a foreigner, and subsequently assigned to the inventor abroad, or to any other person that he may appoint.

All patents for inventions are granted upon certain conditions, with which the patentee must comply, upon pain of forfeiture of the grant. One of these conditions is, that he shall, within a certain time, (generally six months,) from the date of the patent, enrol a specification, or description, of the invention. This document must clearly and intelligibly explain and point out the nature of the invention, and also the manner of carrying it into effect. Neglect to enrol the specification within the proper time; furnishing an incorrect, or unintelligible, description of the invention, either by ignorance, or with intent to mislead the public; or withholding any information that is absolutely necessary for perfectly understanding the invention, involves the forfeiture of the grant, and, of course, the loss of the fees paid for the patent.

The obligation to enrol a specification, or description, of the invention, is intended to effect a double object; namely, first, to inform other inventors in what the improvements consist, and thereby prevent them from patenting a similar invention, or infringing upon one already protected; and secondly, that when the patent expires, such a description of the invention may remain on the record, as will enable any other party to carry the improvements into operation without the assistance of the original inventor. As a patent, or exclusive privilege, to make, use, or sell, an invention, for fourteen years, is granted to the author, upon condition of his divulging the secret, for the use of the public after the expiration of the patent right, any ambiguity in the description, or attempt to mislead the public, whereby the patentee may seek to retain any advantage to himself, after the fourteen years, will, as before mentioned, involve the forfeiture of the grant, as the patentee does not then act up to his contract. More patents have been declared void from inaccuracy, and insufficiency of the specification, than for any other cause; and, therefore, it is of

the greatest importance that the specification should be carefully drawn up by a person conversant with such business.

As many inventors erroneously conceive, that by enrolling the specifications of their inventions before others who have patents for similar inventions, sealed a short time previous to them, they will gain the advantage of priority, it must be distinctly understood, that no advantage whatever can be thereby obtained; in fact, it is, on the contrary, an unnecessary and premature exposure of the invention, and may, in some cases, prove injurious in the highest degree, to the interests of the inventor, or patentee. The delay of six months, from the date of the patent, for the preparation and enrolment of the specification, is granted to the patentee, on purpose to give him the opportunity of making such trials and experiments, on a large scale, as will enable him to perfect any of the details of the invention, and, therefore, enrol a specification comprising all his recent improvements. Now, as a patent bears date, and the exclusive right commences, from the day on which it is *sealed*, as before mentioned; and as nearly all patentees are allowed six months for the enrolment of their specifications, it will be easily understood, that if two persons obtain patents under the same title, say "*certain improvements in steam engines*," at different dates, the inventor, whose patent is first sealed, can, if he obtains any information of the invention of the second party, avail himself of it in the preparation of his specification. For example, let us suppose that the patent of one inventor, A, is sealed on January 1st, while that of another person, B, for a similar object, bears date February 1st, both being allowed six months for enrolment: if B, enrols his specification on March 1st, and, therefore, previous to A, erroneously supposing, as inventors sometimes do, that by adopting this course, he will thereby anticipate the latter, and obtain some advantage over him, B, not only does not improve his position, but virtually puts his rival A, in possession of full particulars of his invention, or enables him to obtain them, as, immediately the specification is enrolled, the latter, or any other person, may either inspect it, upon payment of a small fee, or, if he thinks proper, procure an office copy of it, and extract therefrom any portion which he may consider important, or likely to prove useful to himself; and although this may appear to be a flagrant act of injustice, it would be next to impossible to obtain any remedy, if the piracy were cleverly managed, as the second patentee voluntarily puts himself in a position that he has no occasion to occupy, and, in fact, ought not to assume. It may be argued that the publicity given to the invention, from making the necessary experiments and trials above mentioned, is, of itself, sufficient to explain the improvements to any intelligent person, and, in some cases, it undoubtedly is; but there is no occasion to add to this, by enabling parties to obtain a correct description and drawings of the invention, whereby they can ascertain all the peculiar features of novelty, especially as no possible advantage can be derived therefrom. For the above reasons, therefore, it will be at once understood, that if, when an inventor has obtained his patent, other patents for similar subjects remain unspecified, it is not only advisable to refrain from

enrolling until the last day, or two, of the six months, but all unnecessary publicity should, as far as possible, be avoided. If no interfering inventions are in the way, of course, this latter caution is unnecessary.

The specifications of English, Scotch, and Irish patents, must be engrossed on stamped parchment; the first skin bearing a stamp of £5, and every additional one a further stamp of £1. The amount of fees payable on enrolling the specification in the High Court of Chancery, will, of course, depend upon its length, consequently it would be impossible to give a correct estimate of the expenses of preparing and enrolling a specification. There are, in London, three different offices in which the specifications of English patents may be legally enrolled, namely, the Rolls Chapel Office, which contains the records from a very early date; the Inrolment Office, and the Petty Bag Office. The fees of enrolment differ in each of these offices, the charges at the Rolls Chapel Office being considerably less than either of the others; but there are some official regulations connected with the latter office, which some patentees think objectionable. The specifications of Irish patents are enrolled in Dublin, and those of Scotch patents in Edinburgh. Before the passing of the New Stamp Act, whereby the stamp duties of England and Ireland were assimilated, Irish specifications bore a stamp of £1 on each skin; but by the recent Act, an additional stamp was added, making it now £5 on the first skin, and £1 on every following one, as in England and Scotland. In addition to the stamps and fees above mentioned, it may be necessary to prepare drawings to accompany the specification—this again adds to the cost. But in order, however, to give inventors some idea of the probable expense, we may mention that when the description is of moderate length, and does not exceed one skin, accompanied with an explanatory sheet of drawing, it may be fairly taken at from £15 to £20. The total cost of patents for the whole of the British dominions, if unopposed, and obtained under *ordinary* circumstances, will, therefore, be as follows:—

England, Wales, and the Colonies, and the Channel Islands, ...	£115
Scotland, ...	82
Ireland, ...	134
Three Specifications, say £15 each, . .	45
Total, ...	£376

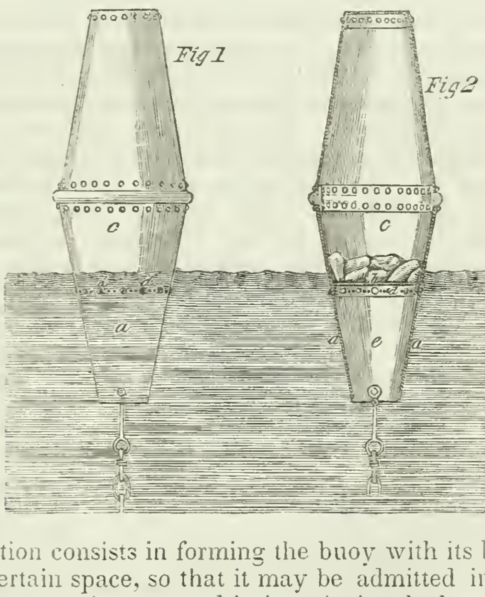
Specification of a Patent granted to WAKEFIELD PIM, *of the county of York, for his invention of certain improvements in the construction, or formation, of Buoys, or other water marks. Sealed* 18*th March*, 1843.

These improvements consist in so making, or constructing, buoys, or water marks, that they may be rendered more efficient in service,

in consequence of greatly increasing the lightness, or buoyancy; and also reducing the amount of ballast with which they are usually charged, to enable them to preserve their erect position in the water. Buoys made in the ordinary manner, when of considerable size, with closed ends, top and bottom, require several hundreds weight of ballast to bring them "over end," or cause them to float in an erect position, or nearly so, in the water, which ballast, or weighting, compels the buoy to be immersed fully one-half in the water.

One of the most important objects of a buoy, is that it may be seen as far off as possible, and, consequently, the less it is hidden by immersion, of the greater service it becomes. And another great feature in its construction is lightness; as by weight, the difficulties of mooring and unmooring the buoy are much increased.

In order to effect these important objects, the patentee constructs the buoy in the peculiar manner exhibited, in which fig. 1, is an external elevation of a buoy, or water mark, and fig. 2, a section, taken vertically through the middle of the same.



The invention consists in forming the buoy with its lower end *a a.* open, for a certain space, so that it may be admitted into the water with little, or no, resistance, and in introducing the bottom, or closing plate *b b,* at nearly one-third of the length of the buoy upwards, so as to close the chamber, or space, *c,* and support the necessary ballast. There are apertures *d d,* made just below the bottom plate *b,* for the purpose of allowing the air to escape, that the lower compartment, or space, *e,* may be entirely filled with water; thus the ordinary ballast, or weighting, may be reduced to about one-third of that usually employed, as the water itself will sufficiently steady the buoy, and retain it in the desired position. It will be evident that buoys so constructed will float much higher out of the water, owing to their increased

buoyancy, and, consequently, be seen, by an observer, at a much greater distance than those in ordinary use, and also be kept much steadier, particularly in a rough sea, or tide, way.

The patentee claims the construction, or formation, of buoys, or water marks, having the lower end open for the admission of water for a certain space, and apertures at the upper part of the open compartment, to allow the air to escape, as herein particularly set forth and described, and also shown in the drawing, whether such buoys, or water marks, be made of iron, wood, or other materials.—Enrolled in the Petty Bag Office, September, 1843.

Lond. Journ. Arts & Scien.

Mechanics, Physics, and Chemistry.

On a re-arrangement of the Molecules of a Body after Solidification. By Robert Warington, Esq.

Having occasion lately to prepare some alloys of lead for the purpose of lecture illustration, I was much surprised at an alteration taking place in the arrangement of the particles of one of these alloys, as shown by the appearance of the surfaces of fracture, after the metal had assumed the solid form. The alloy experimented on was that known as Newton's fusible metal, composed of 8 parts of bismuth, 5 of lead, and 3 of tin. On pouring this alloy, in the melted state, on a marble slab, and breaking it as soon as solid, and when it may be readily handled, the exposed surfaces were found to exhibit a bright, smooth, or conchoidal metallic appearance, of a tin-white lustre; and the act of disjunction, at one part, will frequently cause the whole to fly into a number of fragments, analogous to the breaking a piece of unannealed glass.

The metal after this becomes so hot as to burn the fingers if taken up, and when this evolution of heat has ceased, the alloy will be found to have entirely altered its characters, having lost its extreme brittleness, requiring to be bent to and fro several times before it will break, and presenting, on fracture, a fine granular, or crystalline, surface, of a dark color, and dull, earthy aspect. Similar phenomena accompany the casting of the fusible alloy of H. Rose, composed of 2 parts of bismuth, 1 of lead, and 1 of tin.

The fact of the evolution of heat from the alloy of Newton, and its cause, are thus noticed by Berzelius, in his *Traité de Chimie.* "If this alloy is plunged into cold water, and quickly withdrawn, and taken in the hand, it becomes sufficiently hot, after a few moments, to burn the fingers. The cause of this phenomenon is, that during the solidification and crystalization of the *internal parts,* the latent heat of these is set free, and communicates itself to the surface before the fixing and cooling." The alteration in the internal arrangement of the particles, as proved by the surfaces of fracture, is not, however, noticed, and the explanation is defective, as it supposes the interior not to have assumed the solid state, until the evolution of the heat

occurs. If such were the case it would be seen on breaking it in the first instance. The phenomena can only be accounted for by admitting a certain degree of mobility among the particles, and that a second molecular arrangement takes place after the metal has solidified; this may arise from their not having assumed, in the first state, that direction in which their cohesion was the strongest.

That a very marked and extraordinary alteration in the characters and properties of various substances, arises entirely from this change in the position of their component particles, effected either by the communication, or abstraction, of heat after solidification, there can be no doubt. And these changes are applied to many very important purposes in the arts and manufactures; such as the hardening and tempering of steel, the rolling of commercial zinc, and rendering that metal permanently malleable, the annealing of glass, and a variety of other uses, particularly in crystalization, which might be adduced.

The following experiments were made to ascertain to what extent the emission of latent heat takes place. The melted alloy was poured in a perfectly fluid state on the bulb of a thermometer placed in a small platinum crucible, having a capacity equal to about 70 grain measures of water, and standing in a vessel of cold water, or mercury. The thermometer, surrounded by the solidified metal and crucible, was removed from the cooling medium before it had reached its stationary point, and the greatest decrease of temperature noted. The heat then rose rapidly again, and the maximum effect was registered. The fusing point of the alloy was 202° Fahr.; the following results were obtained:—

Exper.			Fahr.			Fahr.	Diff. Fahr.
1,	thermometer	fell to	97°	and then	rose to	157°	60°
2,	"	"	94	"	"	149	55
3,	"	"	90	"	"	150	60
4,	"	"	87	"	"	147	60
5,	"	"	104	"	"	156	52
6,	"	"	97	"	"	148	51
7,	"	"	92	"	"	152	60
8,	"	"	104	"	"	155	51

So that in four, out of the eight, trials a difference of 60° Fahr. was rendered apparent.

In a platinum crucible of larger size, the effects were not so marked, 34° Fahr. being the greatest difference obtained; this, of course, would arise from the greater bulk of the melted metal not exposing comparatively so large a surface to the cooling medium.

Mem. Chem. Soc., Lond.

On the conversion of Benzoic Acid into Hippuric Acid, in the Animal Economy. By Mr. Alfred Baring Garrod, *of University College.*

A paper has appeared in the Medico-Chirurgical Transactions for last year, and also in the first number of the Pharmaceutical Trans-

actions, by Dr. Alexander Ure, in which it is stated, that by the internal administration of benzoic acid, or any of its salts, hippuric acid is formed in the system, and is eliminated from the kidneys in the form of a soluble hippurate, and that this hippurate is formed by the benzoic acid uniting with uric acid. It is also stated, that no trace of uric acid, or any of its salts, could be found in the urine after the administration of the benzoic acid.

I have repeatedly performed Dr. Alex. Ure's experiment, swallowing from a scruple to half a drachm of benzoic acid at a time, and have always obtained a copious crop of crystals of hippuric acid, amounting to from fifteen to twenty-nine grains, by the addition of hydrochloric acid to the urine, passed about three, or four, hours afterwards, (evaporated, or not, according to its state of dilution.) These crystals possessed all the characters of hippuric acid, with the crystaline form, the small solubility in cold water and ether, the ready solubility in alcohol, the evolution of nitrogen, and also the odor of the tonquin bean when heated to destruction; and my experiments, therefore, so far confirm Dr. A. Ure's fundamental observation. He also mentions another test of hippuric acid, viz., that when evaporated to dryness with dilute nitric acid, and ammonia added, a beautiful purple color is produced. This is certainly true of the crystals obtained from the urine, but it is not a character of pure hippuric acid. The cause of this color will be shown presently.

Dr. A. Ure states that no trace of uric acid could be found in the urine; but on examination I have always been able to obtain a distinct trace of uric acid from a drop or two of the urine, by adding a little nitric acid, carefully evaporating, and holding the capsule containing it over ammonia, when a distinct trace of murexide was formed; also, when the dish containing the crystals of hippuric acid is carefully examined, minute grains are found at the bottom, which are uric acid crystals; and on examining the crystals of hippuric acid with the microscope, uric acid crystals are found adhering to them in immense numbers, and this is the cause of the production of the purple color spoken of, and which has been given as a test of hippuric acid. When the crystals are dissolved in alcohol the uric acid is precipitated, and the hippuric acid crystalized from the alcoholic solution no longer gives the purple color. On collecting the uric acid from the same quantity of urine, formed on successive days, the same food being taken, one containing about twenty-seven grains of hippuric acid, and the other none, the following results were obtained:—

From 4½ oz. of urine, when no benzoic acid had been taken, uric acid 1.07 grain.

From 4½ oz. of urine, after taking 30 grains of benzoic acid, uric acid 0.96 grain.

Difference in favor of first 0.11 grain.

In the second experiment also, a small loss might have occurred from the greater washing of the crystals necessary in that experiment. Now if we suppose that uric acid is decomposed to afford the elements necessary to be added to benzoic acid to form hippuric acid, we find that each equivalent of benzoic acid requires the addition of

$C_4\ H_6\ O_4\ N$. To obtain the nitrogen, four atoms of benzoic acid would require one atom of uric acid, or half a drachm of benzoic acid would require rather more than ten grains of uric acid. Now the quantity of urine, in the experiment without the benzoic acid, only contained 1.07 grain of uric acid, and yet that quantity was not materially diminished when twenty-eight grains of hippuric acid were found in the urine. It cannot, therefore, be from the uric acid that the hippuric acid is formed.

If we examine the subject theoretically, it does not seem probable that such a body as benzoic acid, possessing such feeble affinities, and producing no sensible action on the body when taken, should be able to break up such a stable compound as uric acid; to abstract from the latter the requisite elements for its conversion into hippuric acid: but as hippuric acid is really formed in the urine, from whence does it obtain the necessary addition? The quantity of urea was noticed in several experiments to be deficient; could this be the source? We can find no rational formula for the explanation of the conversion, if we suppose it to be from urea alone. We can, it is true, select the elements required; but, as in the last case, we should leave some compound in the system, which cannot be resolved into any known compounds, as ammonia, water, carbonic acid, &c., while from the ready conversion of the benzoic acid into hippuric acid we should expect that the change was one which could easily take place, without the action of any unusual affinities being brought into play. It occurred to me that it might be the lactate of urea, instead of pure urea, which is taken up; and upon comparing the formula for hippuric acid, benzoic acid, and the lactate of urea, it appeared that one equivalent of lactate of urea minus three eqs. of water, gave exactly the requisite elements for the conversion of 2 eqs. of benzoic acid into 2 eqs. of hippuric acid. 2 eqs. of benzoic acid + 1 eq. of lactate of urea = 2 eqs. of hippuric acid + 3 eqs. of water.

Hippuric acid, (anhydrous)	$C_{18}\ H_8\ O_5\ N_1$,
Benzoic acid, (Do.)	$C_{14}\ H_5\ O_3$,
Difference, . . .	$C_4\ H_3\ O_2\ N_1$,
Twice the difference, . .	$C_8\ H_6\ O_4\ N_2$,
Lactic acid, ...	$C_6\ H_5\ O_5$,
Urea, ...	$C_2\ H_4\ O_2\ N_2$,
Lactate of urea, . . .	$C_8\ H_9\ O_7\ N_2$,
Lactate of urea, — 3 H O =	$C_8\ H_6\ O_4\ N_2$.

Now the urea has, by MM. Cap and Henry, been found to exist in human urine as lactate, and the separation of the elements of water is a change which might be expected to take place in the system under such circumstances. The benzoic acid merely taking up the lactate of urea, and throwing off water, is certainly a more probable occurrence, than the destruction of such a stable compound as uric acid.

In analyses for the quantity of lactate of urea, according to the method of Cap and Henry, I found that although I could not obtain it in crystals, yet the quantity in a siropy state was much reduced

after taking the benzoic acid, and the same appeared on forming nitrate of urea from it. I obtained 14 grains less of urea in 4½ ozs. of urine when the benzoic acid had been taken. In another experiment I obtained 17 grs. less of urea when 30 grs. of benzoic acid had been taken; this is a greater loss than can be accounted for by the formation of the hippuric acid; but this can be referred to the urine, from some accidental circumstance, being of nearly as high specific gravity, in this case, as when the benzoic acid had been taken. 30 grs. of benzoic acid, swallowed, usually increased the specific gravity of the urine from four to six-thousandths.

From these results two inquiries suggest themselves:—1st, may not hippuric acid be formed artificially out of the body? 2nd, if sufficient benzoic acid were swallowed at such a time when the least urea was contained in the urine, would the benzoic acid not cease to be all converted into hippuric acid, part of it then appearing in the urine unchanged? Ibid.

Iron Founding.—From the Glasgow Practical Mechanic and Engineer's Magazine.

(Continued from page 196.)

Section IV.—Loam-Moulding.

Loam-moulding, the last branch of the art, as it has been treated in these papers, falls to be discussed in the present article. As already described, the peculiar functions of the loam-moulder is to construct loam patterns and mouldings of certain cast-iron work, by which the mould may be formed without incurring the expense of the construction of a wood pattern for that purpose. In many cases, also, the loam-moulder constructs moulds for which wood patterns could not be provided. The economical employment, however, of loam as a substitute for wood patterns and sand, is restricted, in general, to the manufacture of the more regularly shaped work of a foundry. Every variety of circular bodies may be done in loam: large square vessels, too, are done by the same process.

Every piece of loam-moulding, of any considerable extent, is a regularly built structure, being composed of bricks, arranged in layers, and bedded in loam, in which they are also entirely enveloped, particularly on those sides contiguous to the mould. The composition of loam demands strict attention, varied, as it requires to be, suitably to the various applications of loam. Two indispensable qualities are those of firmness and porosity. The first is evidently necessary, considering the very great hydrostatic pressure to which, in large castings, mouldings are subjected, while the iron is liquid. And again, the copious effusion of gases from the mould, arising from the action of the heat of the cast, renders it absolutely necessary to provide for their escape through the material of the mould. This is provided for in the porosity of the mass, which must, therefore, be in such a degree as to offer a transit sufficiently free to the airs evolved, while the mould

is impervious to the metallic fluid. To fulfil these conditions, the materials of loam are principally clay, and clean sharp sand. These elements are opposed in their nature, and operate as counteractives. The clay is the binding element, from which the loam derives its firmness: the sand, intermixed with it, modulates its closeness, and renders the loam open in the grain. Thus, both these elements are essential in the composition of the substance. Cow hair, also, obtained from hides of cattle by tanning, is mixed in loam: it answers two purposes. In the first instance, while the raw loam is being moulded into the form desired, the hair assists the tenacity of the parts of the loam, which is often largely charged with water. Again, when loam work is baked in the stove, which, for cores, is raised to the greatest attainable temperature, the hair is burnt out of the loam, and, of course, leaves its own empty track. The mould is thus perforated in all directions, throughout, by these artificial sinuosities; and in this way the openness of the mould is very much increased. Mill-seeds, saw-dust, horse-dung, and straw, especially the last, are also extensively used in the formation of loam cores. It ought to be understood that loam cores must be completely dried and burnt before they can be serviceable; the object being to anticipate the work of the hot iron, with which they must afterwards come in contact, by expelling completely their humidity, and the occasional gases originated by the burning of their combustible matter. Were this precaution not taken, particularly for cores much confined, they would inevitably be broken up by the sudden generation of confined air, which could not escape as suddenly. It may be as well to state here, that the general results of the action of melted iron on the mould are carbonic acid and oxide, and carburetted hydrogen. In the first place, the carbon constituting the blackening used in all moulds, and the coal powder in green sand moulds, seizes and combines with the oxygen of the aqueous particles in the neighborhood, forming a mixture of carbonic acid and oxide; the hydrogen of the water thus let loose, combines with another portion of carbon, producing carburetted hydrogen, which, with the carbonic oxide, burns with a bluish yellow flame on coming in contact with the external atmosphere.

For all varieties of circular bodies, or such as may be described round one axis, a wooden board is cut on one edge to the exact form of the object, being, in fact, a half skeleton of its outline. If the body be cored out, a board must also be provided, cut to the form of the interior space. A central spindle is erected, which is to represent the centre of the body to be moulded; to this spindle one, or more, arms are screwed, provided with glands, by which the *loam board*, as it is termed, is set at the proper radial distance from the centre, and firmly fixed to it. The whole being in this condition turned round the centre, it is obvious that the figure of the body will be described. With this general idea, we shall proceed to particular description.

Sugar pans are among the most familiar examples of loam casts, and, as they are in themselves instructive specimens of this kind of work, they shall be selected as our first illustration.

Fig. 1, Plate I, is a general view of a Carron shaped sugar pan.

The portion *a b*, constituting the pan, is a simple spherical cone, and *b c*, is the brim.

The pan is moulded and cast in an inverted position, similarly to the Irish pots already described. In the first place, then, a cast-iron ring, *a a*, fig. 6, Plate I, is leveled upon blocks, which raise it off the floor of the foundry, and is placed concentric with a spindle, *b*, which stands upright, being placed at the under end in a cast-iron step sunk in the floor, and stayed at the upper end in a bush on the end of a bracket, *c*, which projects from the wall, and turns horizontally upon pivots. The spindle thus stayed is free to move round in both directions. To prevent the bracket from moving on its pivots, it is linked by the extremity to the wall. A forked arm, *d*, is fixed upon the spindle by an eye at one end, tightened by a pinching screw. Between the branches of this arm the loam board, *e*, is set, and fixed by glands in the required position.

Fig. 2, represents the outlines to which the loam boards are cut; *a b c*, is the figure of the interior surface of the pan, *b d*, being the axis. A board, *e*, is, in the first place, cut to the semi-outline of the interior; and, further, has an additional check, *o*, which turns out a corresponding knee in the mould, the object of which is to support the overlying part of the mould on its horizontal surface, and to act afterwards, by its vertical surface, as a guide in replacing the mould. Another board, *f*, is in the same way cut to the external figure of the pan, with a check precisely similar to the one in the board, *e*; and thus it will act as a guide in setting the second board.

Fig. 3, is a vertical section of the work in the first stage of its progress. Upon the ring, *a a*, a kind of dome, *b b*, is, in the first place, built of bricks and loam, generally four inches thick. The moulder is guided in the construction of this dome by the interior loam board, sustained by the spindle. The external surface ought to be everywhere about two inches distant from the surface described by the board, *e e*. Before building up the dome to the crown, coals are placed on the floor within it, which are afterwards kindled for drying the work. The crown is then nearly completed, leaving only a small space round the spindle to allow of ventilation, when the combustion within is going on. By this aperture the moulder is enabled to manage his fire so as to check its progress if necessary. The consumption ought to be very slow, so as to allow of the heat taking effect upon the entire mass.

Over the brick dome a pasty layer of core loam, *c c*, is applied; for it is, in fact, the core that is now being formed. The surface is finished off by a smooth coating of wet loam, the redundancies all over the surface being swept off by the board in its revolution. Upon this surface the inside of the sugar pan is cast. The fire is now kindled, and, as the surface of the mould becomes dry, it is painted over by a brush with a mixture of water and charcoal powder, with a little clay additional. This operation prevents adhesion between the surfaces of the core, and the coat of loam applied to it.

The core board having been removed, it is replaced, as in fig. 4, by the thickness board, *f*, fig. 2, of which the edge describes the externa.

surface of the pan, and, as already remarked, simply rubs against the knee formed round the base of the core. Another layer of loam, *a a*, is then spread over the core, and is rounded off properly by the board similarly to the core itself. This "thickness," it is evident, is the exact model of the pan itself. When well dried, it is blackwashed as was done to the core. The upright spindle is now removed, leaving the small vent-hole through which it passed to promote the complete combustion of the coal. There is now laid horizontally upon the ears of the platform, *d d*, fig. 4, another similar platform like the former, but sufficiently large to pass over the moulding already executed. A new layer of loam, two inches thick, is laid over the thickness, and smoothed by hand. Then, upon the second platform, a brick vault is constructed as before, of which the inner surface applies to the new coat of loam. This contracts a strong adherence with the bricks, which absorb a part of its moisture, while the coat of paint prevents its adhesion to the thickness. The brick and loam covering are named the cope.

The structure is now completed so far as the formation of it is concerned. The whole mass must now be thoroughly baked by the continuance of the fire. Stoves are preferred to internal fires, when they are large enough to receive the work. The intense heat, however, necessary to the preparation of many cores placed in confined parts of moulds, is not essential to such cores as the above described, where there is so free space within it for the escape of air.

Cast-iron bars may be substituted for the brick forming the cope. These "irons" must, of course, have the curved form of the dome to which they apply, being arranged so as to converge towards the crown. They are simply run off in open sand, when required, with snugs cast upon them, by which the cope may be lifted off. They are bedded in the external coat of loam, which is smoothed over them, and bound together by wires and bands of hoop-iron.

The next step is to lift off the cope, which is done with the assistance of a crane. This being done, access is had to the interior, and the thickness is easily broken away without any injury to the mould; this thickness being, in fact, the pattern of the pan, it is evident that when the cope is replaced exactly, which may be done by the guidance of the knee before described, there will be a space within to be filled by metal, being the true form of the pan. Before replacing the cope, the vent aperture in the core is filled up and smoothed over, though the one in the cope is left open to serve afterwards as a gate for the reception of the metal.

The cope being reset and clamped firmly to the core by double knees and wedges embracing the rings, the whole is removed to the pit in which it is sunk, and rammed up tightly with sand by iron rammers, which are managed by half a dozen, or more, men, who walk regularly round the moulds, keeping time with their rammers, and dealing heavy and light blows alternately, while one or two workmen above shovel in additional sand as required. Fig. 5, is a vertical section of the pit, showing the manner in which it is arranged. A space sufficiently deep is first cleared out, and across the bottom a

passage, *a a*, is cut and overlaid with plates, having only an open part at the centre, which connects it with the interior space, *b*, in the mould. Two pipes, *c d*, *c d*, are next laid in against the sides of the pit, communicating with the channel, *a a*. When the mould is lowered into its position in the centre as indicated, and the sand rammed about it in the way already described, an oblong, shallow trough-like cavity, *e*, is formed in the surface of the sand, one end of which opens into the gate hole of the mould, which is closed by a pin while the ramming is proceeded with.

The channel, *a a*, and the pipes, fulfil the very important purpose of venting the air confined in the hollow space, *b*, together with what is forced through the substance of the core when the metal is poured. Now, as a large quantity of inflammable gas is driven off, its union with the atmospheric air in the chambers below, forms a dangerous explosive mixture, which, rushing out at the openings, *d d*, might be inflamed by accident, and if not prevented would blow up the whole work with irresistible force. To prevent such an occurrence, the vents are stopped at *d d*, with plugs of straw, or mill waste, or simply covered with pieces of fine wire sieve; the gas passing through these substances before being exposed to accidental inflammation, security from explosion is rendered certain, as flame cannot pass through their interstices. The principle alluded to is familiar to all, as exemplified in the Davy lamp, in which the flame in the interior is intercepted by a wire gauze medium.

When the metal has been poured, and has well set, the casting is cleared out as quickly as possible, as, on account of the contraction it undergoes, it is apt to jam upon the core. Confined cores are always broken up as soon after casting as may be, especially when their form is calculated to resist great compressive force.

When the object to be moulded presents more complicated forms than the one now chosen, for the sake of illustration, it is always by analogous processes that the workman constructs his loam-moulds, but his sagacity must hit upon modes of executing many things which at first sight appear to be scarcely possible. Thus when the forms of the interior and exterior do not permit the moulds to be separated in two pieces, it is divided into several, which are nicely fitted with adjusting pins. More than two cast-iron rings, or platforms, are sometimes necessary. When ovals, or angular, surfaces are to be traced instead of those of revolution, no upright spindle is employed, but wooden, or cast-iron, guides, made on purpose, along which the pattern cut-out board is slid, according to the drawing of the piece. In addition to brick work, iron wires, or claws, are often interspersed through the work to increase its adhesion. When parts of a mould are higher than that portion immediately under the gate, flow-gates are usually adapted to such parts, by which they may be relieved of the impurities that would be apt to lodge there. Such a case is that of a flattish bottomed boiler, of which the bottom is hollow externally.

Our second example of loam-mouldings shall be that of the steam cylinder of an ordinary high pressure engine. Fig. 7, Plate I, is a

side elevation of one; fig. 8, is a sectional elevation; fig. 9, represents a horizontal section taken through the centre of the exhaust steam passage; *a a*, are the steam passages to the cylinder; *b b*, the exhaust passage, all uniting in the face *c; d*, is the outlet from the passage *b b*.

It is to be noted that the body of the cylinder is round, while the base, or bottom, flanch *e e*, is square, and the face *f c f*, containing the steam ways, is supplementary to the main part, as also the stiffening feathers for strengthening the base. For these parts, then, patterns in wood are made adapted to fit the loam work. Fig. 10, is front and side views of the pattern of the part *f f*, having core prints *c c c*, for the usual purpose of steadying the cores.

As the upper flanch of a cylinder, such as the one now described, is generally smaller than the under one, and more exposed to view, the cylinder is usually cast in an inverted position, to have the former flanch solid. According to the method now most generally adopted for moulding cylinders, the cope, or external outline, is formed, in the first place, by an interior loam board cut to the form on the outer edge. Thus, the cope is first constructed, after which it is removed, and, on the same centre, the core, or interior outline, is formed by an external loam board cut on the inner edge. If now the cope be replaced concentric with the core, they will include between them a vacant space, being the exact figure of the cylinder. Fig. 11, represents the two first stages of the work; the core ring *a a*, seen in section, being of the dimensions necessary for the work, is first laid down concentric with the spindle *b*, and leveled off the ground upon blocks. To the arm *c*, projecting from the spindle, the loam board *d*, is fixed by glands embracing two arms nailed upon it. This board is cut to form the bearing *e*, of brick and loam for the core, the bearing acting also by its sloping edge as a guard in closing the mould.

Its upper surface now forms the lower side of the cylinder flanch. The board is now altered as expressed at *f*, on the opposite side, so as to form the flanch *i*, which is made simply of loam. This is the second stage of the work, and the flanch must be dried like the bearing before it, to prepare for the next stage. It is necessary to form the flanch singly, to be an additional bearing upon which the superstructure is founded. If it were cut at once out of the cope, the overhanging loam must give way.

The arm *c*, is now shifted up along the spindle sufficiently high for the next operation, represented at fig. 12. A loam board *d*, is cut to the form of that part of the cylinder included between the extreme flanches—these themselves, as we have stated, being made of loam and wood. The board includes the exterior outline of the circular exhaust passage; and it will be seen that, when set in motion, it touches the flanch at the bottom, and a horizontal piece *b*, projects from it to the top to sweep a flat surface on the cope, upon which the square flanch is to be laid. The arm *c*, is assisted in holding the board by two pieces of iron *f*, at the bottom, screwed together upon the spindle and the board, the cope ring *h*, having been laid down upon the core ring *a a*, surrounding the bearing *e*, with a little space

between them. The steam way pattern, fig. 10 is set in its place in an inverted position, resting on the flanch *i*. Its precise position will be ascertained by the loam board, which ought to touch it when passed round. The building is commenced upon the cope ring; and, having been raised above the flanch *i*, another ring *k*, is bedded on the building, lying near into the loam board, with a segment cut out of it sufficient to clear the steam way pattern on both sides. Upon this ring the building is continued till near the under side of the exhaust passage, at which place a similar ring *l*, is bedded on the structure, overhanging it sufficiently to sustain the building round the passage, at which place it is greater in diameter. Having built up the height of the passage indicated by the board, a layer of loam on the top is swept flush with the upper side of the projection by means of a transverse stick nailed on the board. This forms a parting surface, by which the cope is divided into two parts, the necessity of which is apparent on considering the method of placing the cores for the exhaust passage. After blackwashing the surface, a third ring *m*, with projecting snugs on its rim, is laid over it, being faced, however, with a layer of loam to protect it from the melted iron. The building is continued upon this plate till it reaches the top, when it is succeeded by another plate *n*, of a square external form, and somewhat larger than the square base plate of the casting immediately over it. The building is finally carried up to the horizontal piece *b*, which smooths off the upper surface with loam.

It will be remembered that the mould is on one side, cut longitudinally throughout, by the pattern of the steam ways. On that side, therefore, it has to be completed; this object is attained by providing a cast-iron plate, done in open sand, fitting generally the interior of the pattern, and having three openings through which the core prints are passed when the plate is applied. It is daubed all over the inner face with stiff loam, and being set up in its place, the loam receives the impression of the face of the pattern. Lastly, the square flanch pattern is laid over the whole, upon the bed prepared for it; preceded by the four stiffening flanches, and is surrounded with additional loam, flush with its upper side, to form a bearing for the top plate.

In the manner thus described, the external figure of the cylinder is formed. The whole mould from the bottom is lifted by the snugs on the cope ring *h*, off the core ring, upon which the two layers *e* and *i*, are left. It is conveyed to a sufficient stove to be thoroughly dried.

This is an operation comparatively simple, as the core is but a simple cylinder of brick and loam. In the first place, as the loam flanch *i*, has formed its impression on the interior mould under the plate *k*, it is of no further use, and is, therefore, broken away, leaving the bearing clean to receive the core, as represented on the left side of fig. 12; *o*, is the loam board in its proper position for working, having its inner edge set parallel to the spindle, and to the diameter of the cylinder required, and simply fixed to the arm at the top. A cylinder of brick work *p*, is first built up, being every where an inch or so clear of the board. A coat of loam *s*, is next laid on as usual,

to fill up the clearance, and complete the core. The board and the spindle being removed, the work is lifted away to the stove on the core ring *a a*, by the snugs upon its rim.

The next business of the moulder is the formation of the smaller cores, which are to form the winding steam passages to the cylinder, of which there are three; the two supply passages *a a*, and the exhaust passage *b*. The two former being of the same shape, may be formed from one core box, seen in plan and section at fig. 6, in which *a*, indicates the core boxes; for such kinds of cores are usually formed on three sides, and open on the fourth side to admit the material, which is shaped off on this side by the edge of a piece of wood cut to the contour of the core, and drawn along upon the sides of the core box as guides. The core for the exhausting way is partly circular, and partly otherwise at the ends. Its formation is thus more complicated than that of the other cores. It is made in three parts; the centre part annular to embrace the cylinder, and formed by a loam board, and the terminations made in core boxes, and fitted to the other; fig. 14, is a vertical view of the method of making the annular core. It is built upon a portable square table, convenient for small, circular work generally, as it may be conveyed to the stove without the necessity of shifting the centre. The spindle turns by a conical pivot on its under end moving in a socket, which is the only staying it requires. A block *a a*, is first prepared, being a plain built ring of which the exterior is smoothed with loam, and is made exactly to the interior diameter of the core, and to the same depth. The core seen in section at *b*, is run upon the outside of the block to the necessary thickness, in the course of which two wrought-iron angular rods are imbedded in the core to impart their stiffness to it. At *b'*, is shown the valve face portion of the core, (at *c*, fig. 8,) of which *c*, is the box for making it in section. The round core for the short, straight passage *d*, fig. 16, is made of loam, being run up on a short iron centre.

In the making of these small cores, as in that of green sand, it is necessary that they be strengthened with iron rods bent to their form, so as to pass through the heart of them, and finished with eyes at the outer extremities, for locking them to the face plate. An open passage, running through each core, is formed, as in green sand cores, by laying pieces of cord along the irons. These passages are of great importance, as, upon them depends the escape through the openings in the face plate, of the otherwise confined air existing in the mould, while the metal is being run. The too close proximity of these passages at any point to the surface of the cores must be well guarded against. In such a case, the melted metal in contact with the core breaks into the interior of it, and intercepts the air in its escape, which aggravates the evil, by forcing it into the body of the metal, and thus rendering the casting unsolid. The accident even assumes, in some cases, a more serious aspect, by causing such an agitation in the metal as to render the cast utterly useless; indeed, we have even seen the metal already poured almost wholly expelled from the mould, and sent in showers through the foundry, the occurrence being entirely attributable to an oversight of the nature referred to.

Fig. 15, is a side view, in section, of the mode of placing and fixing the cores *a a*, for the steam ways to the cylinder; *q q*, is the face plate lined with stiff loam, which retains the impression of the steam way pattern; *a a*, are the two cores, the nearer ends of which are passed through the openings made in the plate for them, and fixed there by small rods passed through the eyes of the stiffening irons. The ends are made with shoulders which bear upon the upper side of the plate, fig. 15, which may be understood from the form of the prints in fig. 10. The horizontal parts of the cores *a a*, fig. 15, are supported at their proper distance off the loam work beneath them, by steeples stuck into it.

The mould and the cores having been well dried, they are dressed and smoothed where necessary, and finished with a coat of coal powder. Fig. 16, is a vertical section of the whole mould, showing all the parts fitted to one another, so as to contain among themselves the vacant space indicated by a white ground, into which the metal is delivered. The mode of depositing and putting together the mould is as follows: the main core *p p*, is lowered upon its rings, from which it is never separated, into a pit dug in the floor of the foundry sufficiently deep to receive the core below the surface. The exhaust passage core is next deposited in its exact position in its place on the top of the lower part of the cope, being sustained in the usual manner off the core by chaplets made of two pieces of strong hoop iron, riveted on the ends of two studs, so as to have the necessary thickness of space. The lower part of the cope, thus furnished, is next lowered over the main core into its place upon the core ring, thus surrounding the core, and containing within it a space between, as indicated in the figure. Another set of chaplets are deposited upon the exhaust core, which, by being in contact with the upper half of the cope when placed above, prevent the core from floating off its seat when immersed in the fluid metal. This is a matter of greater moment than the sustaining of the core from below, as will be apparent on considering the great difference of specific gravities of dry loam and iron. In this case the upward effective pressure of the fluid metal upon the core, is proportional to the difference of their specific gravities, which being so much in favor of iron, the pressure upwards, sustained by the chaplets, cannot be much less than the weight of a body of iron of the same bulk as the core. Therefore, as a safe general rule, chaplets are, or ought, to be made of sufficient strength to resist the weight of a body of iron equal in bulk to the core, for the support of which they are destined.

The upper part of the cope having been let down into its place, the face plate with its cores fixed to it, fig. 15, is let down in front of the vacancy in the side of the cope, till it arrive at the proper height, when it is set close into its place, and the end of the exhaust core *b*, receives *d*, through the middle opening in the plate, and secured on the outside by the eye. The branch core *d*, is then set in, and supported on chaplets, and over it a ring, or cake, of loam *m l*, seen in section in the figure, is placed, being strengthened internally with

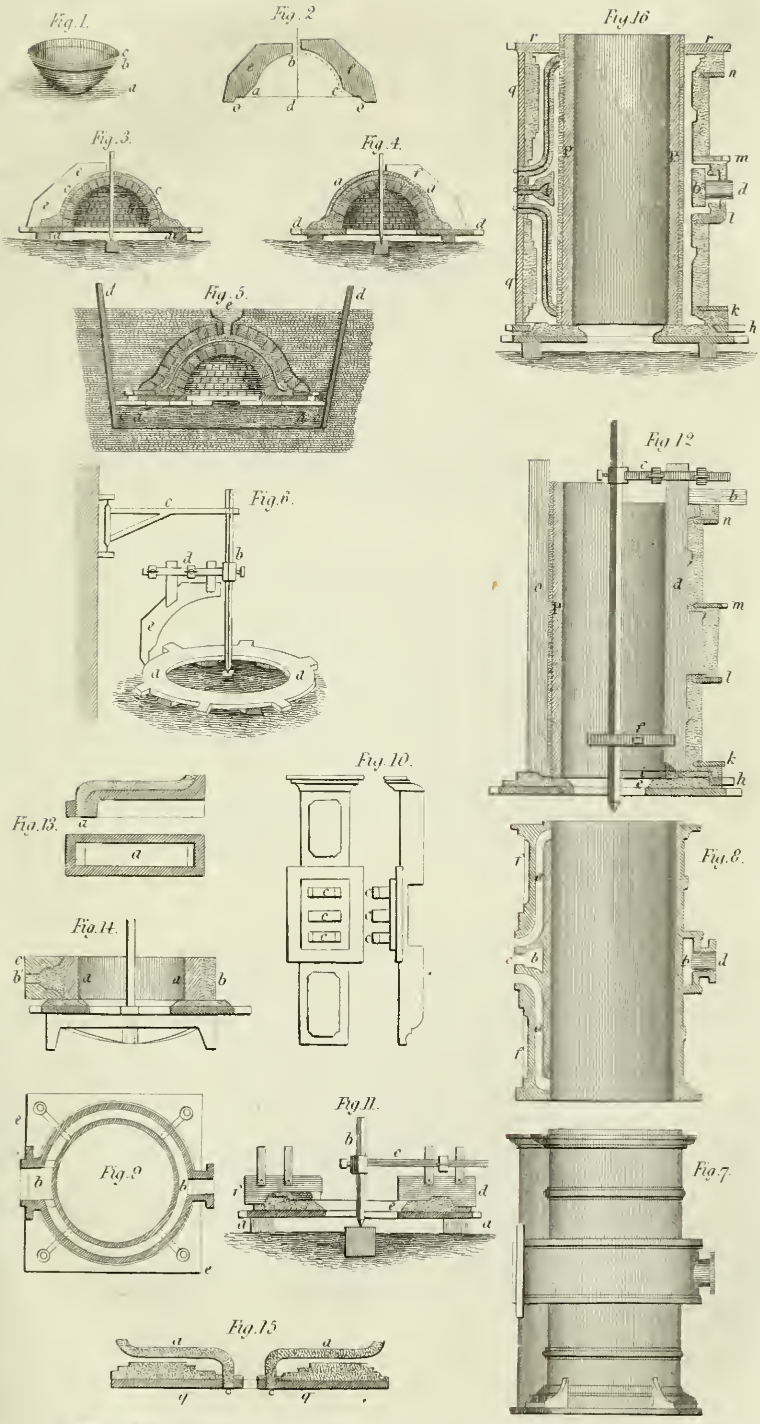


Fig. 1.
Fig. 2
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9
Fig. 10.
Fig. 11.
Fig. 12
Fig. 13.
Fig. 14.
Fig. 15
Fig. 16

iron, like the cores. Thus the cake of loam forms, by its inner surface, the outer surface of the flanch.

The mould being all finished below the top, the pit sand is rammed tightly round it, to enable it to withstand the pressure of the metal, air vents being provided in a manner similar to those for the sugar pan mould already described. The top plate *r r*, is laid on lastly, holes being provided in it for the admission of the metal. It is covered in with sand, through which passages are led up to form the holes to the external surface as runners.

To be Continued.

Extraction of Palladium in Brazil.

The extraction of palladium, from the auriferous sand of Brazil, consists in fusing it with silver, and, consequently, forming a quaternary alloy of gold, palladium, silver, and copper, which is granulated by projecting it into water.

By treating this alloy with nitric acid, the gold is separated from the other metals which are soluble in the acid; the silver is precipitated by a solution of common salt in the state of insoluble chloride, which being separated, the copper and palladium are precipitated by plates of zinc. The pulverulent deposit of these metals is redissolved in nitric acid, and the solution precipitated by excess of ammonia, which redissolves the oxide of copper and of palladium. When the ammoniacal solution of these metals is saturated with hydrochloric acid, a double chloride of palladium and ammonia is deposited in the state of a crystaline yellow powder, and this, when calcined in a crucible, is readily decomposed, and leaves spongy palladium.

Philos. Magazine.

On the Daguerréotype Art.

The secretary next read a paper, by Mr. Claudet, "On the Daguerréotype Art," including a complete history of its origin and progress; one of Mr. Claudet's assistants showing, by means of artificial light, the whole process of producing a picture. The most important part of this communication related to an improvement lately applied; it is a process of engraving on a metallic plate. M. Fizeau is the discoverer of this new mode of engraving. Professor Grove has tried the process, which consists in dissolving, by the electrotype process, those parts of the picture which consist of pure silver. Thus the plate is etched in, and transformed into an engraved plate for printing; the action, however, of the galvanic battery sometimes extends to those parts which should remain unattacked.—*Trans. Soc. Arts.*

Civ. Eng. and Arch. Jour.

Meteorological Journal for 1843, kept at the Lancaster Conservatory of Arts and Sciences, Lancaster, Pa., by WASH. L. ATTLEE, M. D., *Obs.*

		BAROMETER.			EXTERNAL THERMOMETER.					HYGROM'R, 2 P.M.				SKY.				WINDS.			CLOUDS.			R'IN.
		7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	Reg'r	Mean	Dew point.	Diff. dw pt &tem	Wet bulb.		7 A.M.	2 P.M.	9 P.M.		7 A.M.	2 P.M.	9 P.M	7 A.M.	2 P.M.	9 P.M.	G'ge.
														Days.	Days.	Days.		Days.	D'ys.	D'ys.	D'ys.	D'ys.	D'ys.	Incs.
JANUARY.																	N.	2	2	3	0	0	0	
	Att. ther.	36.94	43.92	39.66													N.W.	9	12	12	9	6	1	
																	N.E.	1	1	4	0	1	0	
	Average	29.52	29.46	29.50	30.97	42.55	33.60	29.71	35.71	30.87	9 93	38.95	Ent. clr.	7	8	15	S.	1	3	0	1	1	0	
	Maximum	30.06	30.06	30.12	53.00	58.00	49.50	47.00	51.75	56.50	18.24	56.50	Ent. cld.	10	9	10	S.W.	5	4	1	1	3	0	
	Minimum	28.75	28.53	28.78	3.00	20.00	10.00	2.00	14.00	8.56	0.00	18.00	Part. clr.	14	13	6	S.E.	7	7	7	0	0	1	
	Range	1.31	1.53	1.34	50.00	38.00	39.50	45.00	37.75	47.94	18.24	38.50					W.	3	1	2	5	6	0	
																	E.	3	0	2	1	0	0	
Omitted		0	1	0	0	1	0	0	1	1	1	1		0	1	0		0	1	0	7	5	14	2.260
FEBRUARY.																	N.	1	2	1	0	0	0	
	Att. ther.	27.36	33.58	29.52													N.W.	8	10	10	8	6	3	
																	N.E.	4	2	3	0	0	0	
	Average	29.36	29.34	29.39	22.32	31.52	24.26	22.78	25.88	16.04	15.75	27.65	Ent. clr.	5	4	7	S.	2	2	1	0	1	0	
	Maximum	29.77	29.77	29.85	36.00	48.00	37.00	31.00	38.25	36.00	30.90	40.00	Ent. cld.	9	9	9	S.W.	4	2	1	1	2	0	
	Minimum	28.86	28.84	28.86	8.00	18.00	9.00	6.00	14.25	–4.90	0.00	17.00	Part. clr.	12	11	9	S.E.	2	2	1	0	0	0	
	Range	.91	.93	.93	28.00	30.00	28.00	25.00	24.00	40.90	30.90	23.00					W.	3	4	6	4	3	2	
																	E.	2	0	2	0	0	0	
Omitted		1	4	3	0	3	3	0	3	4	4	4		2	4	3		2	4	3	8	8	13	2.272
MARCH.																	N.	1	3	1	0	0	0	
	Att. ther.	20.08	36.79	32.48													N.W.	15	12	10	3	7	1	
																	N.E.	4	2	4	0	0	0	
	Average	29.39	29.38	29.39	23.76	36.27	26.73	20.92	28.60	19.64	16.28	31.58	Ent. clr.	11	6	16	S.	0	0	0	0	0	0	
	Maximum	29.77	29.71	29.77	41.00	58.00	37.50	35.50	45.00	43.86	37.87	51.00	Ent. cld.	10	8	11	S.W.	1	3	3	1	2	0	
	Minimum	28.76	28.54	28.93	13.50	19.00	11.00	10.00	17.00	4.61	0.00	17.00	Part. clr.	10	17	4	S.E.	3	2	5	1	0	0	
	Range	1.01	1.17	.84	27.50	39.00	26.50	25.50	28.00	39.25	37.87	34.00					W.	4	6	6	6	8	1	
																	E.	3	3	2	0	0	0	
Omitted		0	0	0	0	0	0	0	0	0	0	0		0	0	0		0	0	0	9	8	13	4.475

		Barometer.			External Thermometer.					Hygrom'r, 2 P.M.			Sky.				Winds.				Clouds.			Rain.
		7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	Reg'r	Mean	Dew point.	Diff. dw pt &tem	Wet bulb.		7 A.M Days	2 P.M Days	9 P.M Days		7 A.M Days	2 P.M Days	9 P.M Days	7 A.M Days	2 P.M Days	9 P.M Days	Rain Ga'ge. Inch.
April.																	N.	0	1	2	0	3	0	
	Att. ther.	49,75	60.05	52.30													N.W.	11	12	5	6	8	0	
																	N.E.	5	2	5	0	2	0	
	Average	29.45	29.44	29.44	45.85	57.73	47.63	42.40	50.07	40.63	17.10	49.92	Ent. clr.	7	2	12	S.	2	4	2	0	0	0	
	Maximum	29.74	29.71	29.68	60.00	77.50	60.00	57.00	64.25	67.00	44.54	67.00	Ent. cld.	14	11	12	S.W.	2	2	4	0	5	0	
	Minimum	28.81	28.96	28.97	28.50	38.00	31.00	28.00	34.25	8.46	0.00	34.00	Part. clr.	9	17	6	S.E.	3	4	8	1	4	0	
	Range	,93	.75	.71	31.50	39.50	29.00	29.00	30.00	58.54	44.54	33.00					W.	2	1	3	5	3	1	
																	E.	5	4	1	3	2	0	
Omitted		0	0	0	0	0	0	0	0	0	0	0		0	0	0		0	0	0	8	2	17	2.390
May.																	N.	2	1	2	0	2	1	
	Att. ther.	57.31	67.80	60.37													N.W.	9	8	6	5	5	1	
																	N.E.	3	2	2	0	0	0	
	Average	29.52	29.50	29.50	54.69	67.05	56.35	51.11	59.04	49.03	17.99	57.07	Ent. clr.	5	4	6	S.	4	2	3	1	1	0	
	Maximum	29.83	29.84	29.80	67.00	85.00	71.00	64.50	74.75	65.55	32.19	71.50	Ent. cld.	12	7	12	S.W.	1	5	3	4	5	0	
	Minimum	29.25	29.27	29.18	42.50	50.50	43.00	38.00	46.50	36.28	0.00	47.00	Part. clr.	14	17	12	S.E.	4	4	9	2	1	0	
	Range	.58	.57	.62	24.50	34.50	28.00	26.50	28.25	29.27	32.19	24.50					W.	4	3	4	7	7	1	
																	E.	4	3	1	1	2	0	
Omitted		0	3	1	0	3	1	0	3	3	3	3		0	3	1		0	3	1	6	2	21	4.260
June.																	N.	1	1	1	0	2	0	
	Att. ther.	66.39	77.98	70.72													N.W.	8	4	5	1	3	0	
																	N.E.	1	0	2	0	0	0	
	Average	29.54	29.53	29.53	64.04	77.48	66.57	61.57	69.38	59.25	18.19	65.79	Ent. clr.	8	2	18	S.	4	7	6	0	3	0	
	Maximum	29.88	29.88	29.85	74.00	87.00	77.00	74.00	78.75	71.27	26.53	75.00	Ent. cld.	7	3	1	S.W.	6	9	6	5	9	0	
	Minimum	29.22	29.20	29.26	42.00	55.50	44.00	37.00	49.25	34.23	0.00	46.00	Part. clr.	13	24	11	S.E.	3	3	6	0	0	0	
	Range	.66	.68	.59	32.00	31.50	33.00	37.00	29.50	37.04	26.53	29.00					W.	3	5	3	8	12	3	
																	E.	2	0	0	0	2	0	
Omitted		2	1	0	2	1	0	0	1	1	1	1		2	1	0		2	1	1	6	0	9	2.000

Meteorological Journal—Continued.

		Barometer.			External Thermometer.					Hygrom'r, 2 p.m.			Sky.				Winds.				Clouds.			Rain.
		7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	Reg'r	Mean	Dew point.	Diff. dw pt &tem	Wet bulb.		7 A.M	2 P.M	9 P.M		7 A.M Days	2 P.M Days	9 P.M Days	7 A.M Days	2 P.M Days	9 P.M Days	Rain Gauge. Inches,
July.																	N.	6	2	2	0	3	0	
	Att. ther,	69.75	80,85	73.55													N.W	4	4	5	5	4	2	
																	N,E	3	2	6	0	0	0	
	Average	29.58	29.57	29,56	67,02	80.10	69.73	65,08	73,31	64,23	15.82	69.50	Ent. clr.	11	4	11	S.	2	2	2	0	2	0	
	Maximum	29.87	29.88	29.88	79.00	90,50	79.00	78.00	83.50	72.95	24.24	78,00	Ent. cld.	6	6	3	S.W.	4	9	6	1	3	0	
	Minimum	29,42	29.30	29·38	57,50	67.00	60.00	54.00	64,50	49.68	0.00	59,00	Part, clr,	13	20	17	S.E.	2	2	5	1	1	0	
	Range	.45	.58	.50	21,50	23.50	19.00	24.00	19.00	23.27	24.24	19.00					W,	6	6	4	9	12	3	
																	E.	3	3	1	0	0	0	
Omitted		1	1	0	1	1	0	0	2	1	1	1		1	1	0		1	1	0	4	2	15	4,450
August.																	N,	1	3	2	0	1	0	
	Att. ther,	70,50	78,76	73,03													N.W.	6	7	3	0	2	0	
																	N.E.	7	3	6	1	0	0	
	Average	29.62	29,62	29.62	67,78	77.54	69,38	66.32	71.94	67.25	11.58	70.13	Ent. clr,	7	0	0	S.	3	3	3	1	1	0	
	Maximum	29.86	29.87	29.87	75,00	83.00	75.50	75.00	78.75	75.00	20.92	75.00	Ent. cld.	8	6	8	S,W.	2	2	3	7	4	0	
	Minimum	29.43	29.42	29.36	60,00	67.00	65.00	58,50	65.00	56.08	0.00	64.00	Part. clr,	12	21	13	S,E,	4	5	9	0	2	0	
	Range	.43	.45	.41	15.00	16.00	10.50	16.50	13.75	18,92	20.92	11.00					W.	2	3	3	4	12	1	
																	E.	2	1	1	0	3	0	
Omitted		4	4	1	4	4	1	0	4	5	5	5		4	4	1		4	4	1	9	4	19	5.965
September.																	N.	6	3	5	0	1	0	
	Att. ther.	65.38	73.87	66.58													N.W.	3	3	2	4	5	1	
																	N.E.	3	3	2	1	1	0	
	Average	29.64	29.63	29.62	62.40	72.56	63.10	61.00	66.98	60.36	12.20	64.96	Ent. clr.	7	0	9	S.	1	4	0	0	1	0	
	Maximum	29.93	29.94	29.87	72.50	87.00	75.50	72.50	79.75	73.62	19 57	77.00	Ent. cld.	13	6	9	S.W.	5	4	2	1	4	0	
	Minimum	29.30	29.38	29.39	42.00	54.00	45.00	39.00	49.25	39.93	0.00	49.00	Part. clr.	5	18	6	S.E.	3	0	3	1	1	0	
	Range	.63	.56	.48	30.50	33.00	30.50	33.50	30.50	33.69	19.57	28.00					W.	2	5	5	2	7	1	
																	E.	2	2	5	0	1	0	
Omitted		5	6	6	5	6	6	0	6	6	6	6		5	6	6		5	6	6	10	3	13	6.840

		Barometer.			External Thermometer.					Hygrom'r, 2 P.M.				Sky.				Winds.			Clouds.			Rain.
		7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	Reg'r	Mean	Dew point.	Diff. dw pt &tem	Wet bulb.		7 A.M	2 P.M	9 P.M		7 A.M	2 P.M	9 P.M	7 A.M	2 P.M	9 P.M	Rain Gauge. Inches.
														Days	Days	Days		Days	Days	Days	Days	Days	Days	
October.																	N.	2	0	0	0	1	0	
	Att. ther.	48.81	58.29	51.38													N.W.	11	13	12	1	9	2	
																	N.E.	0	2	2	0	1	0	
	Average	29.47	29.52	29.55	45.03	56.81	47.36	44.73	50.02	43.40	13.23	50.43	Ent. clr.	16	2	8	S.	5	2	3	0	0	0	
	Maximum	29,83	29,87	29.89	59.50	72.00	65.00	59.00	65.50	66.00	25.25	66.00	Ent. cld.	8	7	9	S.W.	5	7	3	6	3	2	
	Minimum	29.09	29 09	29.18	32.00	43.50	31.00	30.00	36.75	28.59	0.00	38.00	Part clr.	7	20	12	S.E.	4	2	2	0	0	0	
	Range	.74	.78	.71	27.50	28.50	34.00	29.00	28.75	37.41	25.25	28 00					W.	4	3	5	2	6	0	
																	E.	0	0	2	0	0	0	
Omitted		0	2	2	0	2	2	0	2	2	2	2		0	2	2		0	2	2	6	8	17	3.985
November.																	N.	2	0	0	1	2	0	
	Att. ther.	41.02	48.18	42.31													N.W.	12	15	11	6	6	1	
																	N.E.	0	1	3	0	0	0	
	Average	29.59	29.54	29.57	35.12	45.50	38.30	33,92	39.98	34.56	10.90	41.32	Ent. clr.	7	4	9	S.	2	3	0	0	0	0	
	Maximum	29.92	29.80	29.88	55,00	65.00	54.00	52.00	57.50	56.44	21.63	60.00	Ent. cld.	9	9	9	S.W.	4	1	2	2	1	0	
	Minimum	29.20	28.92	29.24	19.50	33,00	23.50	19.00	31.25	14.61	0.00	28.00	Part. clr.	11	12	9	S.E.	0	3	5	0	0	0	
	Range	.72	.88	.64	35.50	32.00	30.50	33.00	26.25	41.83	21.63	32.00					W.	4	2	6	4	5	1	
																	E.	3	0	0	0	0	0	
Omitted		3	5	3	3	5	3	0	6	5	5	5		3	5	3		3	5	3	7	7	16	3.190
December.																	N.	1	1	2	1	1	0	
	Att. ther.	35,67	39.12	37.11													N.W.	12	8	6	6	5	2	
																	N.E.	4	4	3	0	1	0	
	Average	29.56	29.52	29.56	30.92	38.35	32.23	28.93	33.79	28.13	10.17	35.13	Ent. clr.	5	2	6	S.	3	3	1	0	0	0	
	Maximum	30.02	29.96	30.07	40.00	45.50	41.50	39.00	40.00	42.50	21.85	42.50	Ent. cld.	14	15	13	S.W.	2	3	5	0	0	0	
	Minimum	29.25	29.21	29.25	9.50	30.50	13.00	7.50	20.75	12.67	0.00	26.00	Part. clr.	11	6	9	S.E.	3	0	6	0	0	0	
	Range	.77	.75	.82	30.50	15.00	28.50	31.50	19.25	29.83	21.85	16.50					W.	3	3	2	5	4	0	
																	E.	2	1	3	0	0	0	
Omitted		1	8	3	1	8	2	0	8	8	8	8		1	8	3		1	8	3	13	10	20	3.336

Meteorological Journal—Continued.

	Barometer.			External Thermometer.					Hygrom'r, 2 P.M.			Sky.				Winds.				Clouds.			Rain.
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	Reg'r	Mean	Dew point.	Diff. dw pt &tem	Wet bulb.		7 A.M. Days	2 P.M. Days	9 P.M. Days		7 A.M. Days	2 P.M. Days	9 P.M. Days	7 A.M. Days	2 P.M. Days	9 P.M. Days	Rain Gauge, Inches.
Average of 1843.												*Total of 1843.*											
1843.																N.	25	19	21	2	16	1	
Att. ther.	49,75	58.27	52,42													N.W.	108	108	87	54	66	14	
																N.E.	35	24	42	2	6	0	
Average	29.52	29,50	29.52	45.82	56.96	47,94	44.31	50.39	42.95	11.60	50.20	Ent. clr.	96	38	126	S.	29	35	21	3	10	0	
Maxim'm	30,06	30.06	30.12	79.00	90.50	79,00	78,00	83,50	75.00	44.54	78.00	Ent. cld.	120	96	106	S.W.	41	51	39	29	41	2	
Minimum	28.75	28.53	28.78	3.00	18.00	9.00	2.00	14.00	-4.90	0.00	17,00	Part. clr.	131	196	114	S.E.	38	34	66	6	9	1	
Range	1,31	1,53	1,34	76.00	72.00	70,00	76.00	69.50	79.90	44.54	61,00					W.	40	42	49	61	85	14	
																E.	31	17	20	5	10	0	
Omitted	17	35	19	16	34	18	0	36	36	36	36		18	35	19		18	35	20	93	59	187	45.423
Average of Winter Months, 1842-3.												*Total of Winter Months, 1842-43.*											
Winter, 1842–43.																N.	4	6	5	2	1	0	
Att. ther.	33.57	40.59	36.17													N.W.	32	37	38	23	23	8	
																N.E.	7	9	13	0	1	0	
Average	29.47	29.44	29.47	28.23	38.82	30.56	27.47	32.63	26.43	11.90	35.09	Ent. clr.	18	15	30	S.	5	7	1	1	2	0	
Maxim'm	30.06	30,06	30.12	53.00	60.00	50.00	49.00	51.75	56,50	30,90	56.50	Ent. cld.	30	30	32	S.W.	12	7	4	4	7	0	
Minimum	28.75	28.53	28.78	3.00	18.00	9.00	2.00	14.00	-4.90	0.00	17.00	Part. clr.	40	40	25	S.E.	12	10	12	0	0	1	
Range	1,31	1.53	1,34	50.00	42.00	41.00	47.00	37.75	61.40	30.90	39.50					W.	10	8	9	15	12	3	
																E.	6	1	5	1	0	0	
Omitted	1	5	3	0	5	3	0	4	5	5	5		2	5	3		2	5	3	24	24	45	7.306
Average of Spring Months, 1843.												*Total of Spring Months, 1843.*											
Spring, 1843.																N.	3	5	5	0	5	1	
Att. ther.	45.05	54.88	48.38													N.W.	35	32	21	14	20	2	
																N.E.	12	6	11	0	2	0	
Average	29.45	29.41	29.44	41.43	53.68	43.57	38.14	45.90	36.43	17.12	46.19	Ent. clr.	23	12	34	S.	6	6	5	1	1	0	
Maxim'm	29.83	29.84	29.80	67.00	85.00	71.00	64.50	74.75	67.00	44.54	71.50	Ent. cld.	36	26	35	S.W.	4	10	10	5	12	0	
Minimum	28.76	28.54	28.93	13.50	19.00	11.00	10.00	17.00	4.61	0.00	17.00	Part. lcr.	33	51	22	S.E.	10	10	22	4	5	0	
Range	1.07	1.30	.87	53.50	66.00	60.00	54,50	57.75	62.39	44.54	54.50					W.	10	10	13	18	18	3	
																E.	12	10	4	4	4	0	
Omitted	0	3	1	0	3	1	0	3	3	3	3		0	3	1		0	3	1	23	12	51	11.125

	Average of Summer Months, 1843.												*Total of Summer Months, 1843.*											
	BAROMETER.			EXTERNAL THERMOMETER.					HYGROM'R, 2 P.M.				SKY.				WINDS.			CLOUDS.			RAIN.
	7 A.M.	2 P.M.	9 P.M.	7 A.M	2 P.M.	9 P.M.	Reg'r	Mean	Dew point	Diff. dw pt &tem	Wet bulb		7 A.M Days	2 P.M Days	9 P.M Days		7 A.M Days	2 P.M Days	9 P.M Days	7 A.M Days	2 P.M Days	9 P.M Days	Rain Gauge. Inches.
SUMMER, 1843.																N.	8	6	5	0	6	0	
Att. ther.	68.88	79.20	72.43													N.W.	18	15	13	6	9	2	
																N.E.	11	5	14	1	0	0	
Average	29.58	29.57	29.57	66.28	78.37	68.56	64.32	71.54	63.58	15.20	68.47	Ent. clr.	26	6	38	S.	9	12	11	1	6	0	
Maxim'm	29.88	29.88	29.88	79.00	90.50	79.00	78.00	83.50	75.00	26.53	78 00	Ent. cld.	21	15	12	S.W.	12	20	15	13	16	0	
Minimum	29.22	29.20	29.26	42.00	55.50	44.00	37.00	49.25	34.23	0.00	46.00	Part. clr.	38	65	41	S.E.	9	10	20	1	3	0	
Range	.66	.68	.62	37.00	35.00	35.00	41.00	34.25	40 77	26.53	32.00					W.	11	14	10	21	36	7	
																E.	7	4	2	0	5	0	
Omitted	7	6	1	7	6	1	0	7	7	7	7		7	6	1		7	6	2	19	6	43	12.415
	Average of Autumnal Months, 1843.												*Total of Autumnal Months, 1843.*											
AUTUMN, 1843.																N.	10	3	5	1	4	0	
Att. ther.	51.74	60.11	53.42													N.W.	26	31	25	11	20	4	
																N.E.	3	6	7	1	2	0	
Average	29.57	29.56	29.58	47.52	58.29	49.59	46.55	52.33	46.11	12.11	52 24	Ent. clr.	30	6	26	S.	8	9	3	0	1	0	
Maxim'm	29.93	29.94	29.89	72.50	87.00	75.50	72.50	79.75	73.62	25.25	77.00	Ent. cld.	30	22	27	S W.	14	12	7	9	8	2	
Minimum	29.09	28.92	29.18	19.50	33.00	23.50	19.00	31.25	14.61	0.00	28.00	Part. cl.	23	50	27	S.E.	7	5	10	1	1	0	
Range	.31	1.02	.71	53.00	54.00	52.00	53.50	48.50	59.01	25.25	49.00					W.	10	10	16	8	18	2	
																E.	5	2	7	0	1	0	
Omitted	8	13	11	8	13	11	0	14	13	13	13		8	13	11		8	13	11	23	18	46	14.015

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Third Report of Meteorological Observations made at Frankford Arsenal, near Philadelphia. By Captain ALFRED MORDECAI, *of the Ordnance Department.*

The results of the meteorological observations, made at Frankford Arsenal, during the three years ended on the 30th April, 1838, have been given in two previous reports, published in the Journal of the Franklin Institute, vol. xix, p. 7, and vol. xxii, p. 30. By the care and attention of Mr. Pigott, the clerk of the Arsenal, observations of the thermometer and rain gauge have been continued up to the end of the year 1843; and in order that they may be made available, for reference and comparison with other observations of a like character, a general abstract, or synopsis, of the whole series of observations, during eight years, is now presented.

I.—*Of the Temperature.*

Since 1838, only two daily observations of the thermometer have been made, viz.,

For the Maximum, at 2h. 30m. P. M. For the Minimum, in January, February, and March, at 6 A. M.; in April, September, October, November, and December, at 5 A. M.; in May, June, July, and August, at 4 A. M.

The general results of the observations, for eight years, are given in the following tables, No. I, to No. IV.

Table I, shows the mean temperature, or half the sum of the daily extremes, for each month, as well as for each season, and for the whole year; also the general mean for eight years.

Table II, shows the mean daily range of temperature, or the mean of the daily differences of extremes, for the same period as in Table I. By combining the numbers in these two tables, it will be easy to deduce the mean daily maximum, or minimum, for any stated period, since the first table gives half the sum, and the second table the difference, of the mean maxima and minima; and half the difference of two numbers added to half the sum, gives the greater, and subtracted from half the sum, gives the less.

Table III, shows the greatest daily range of temperature in each month, that is to say, the greatest change of temperature which has been observed in any day during the month; it will be remarked that the interval of time, during which this change of temperature has occurred, is from 8½ to 10½ hours, and that the change, during that time, has been, in several instances, as great as 39°. Further evidence of the great transitions of temperature in our climate, is afforded by Table IV, exhibiting the highest and the lowest temperatures observed in each month, and in each year.

TABLE I.

Mean Temperature of each Month, and of each Season.

Period.	1836	1837	1838	1839	1840	1841	1842	1843	8 years.
January,	27.72	27.40	36.80	31.44	27.21	34.14	34.79	39.48	32.37
February,	22.72	31.86	24.58	35.15	40 36	31.93	39.11	29.38	31.89
March,	33.54	38.80	40.72	43.61	45.16	44.07	47.65	32.38	41.74
April,	48.30	47.98	46.16	55 25	56.18	49.76	53.46	51.40	51.06
May,	61.51	59.53	57.95	64 30	62.31	59.91	60.51	59.91	60.74
June,	64.61	67.63	73.38	67.90	68.61	73.80	68.87	70.65	69.43
July,	73.49	72.41	79.99	76.68	72.81	76.30	76.65	75.26	75.45
August,	68.32	71.08	77.07	71.62	73.77	74.64	73.34	74.27	73.01
September,	67.38	62.50	66.30	65.56	62.08	68.13	68.07	68.88	66.11
October,	48.36	54.36	52.58	57.71	56.23	49.98	58.52	54.03	53.97
November,	40.78	45.85	42.20	41.28	45.37	41.77	39.74	42.30	42.41
December,	32.47	35.30	31.05	36.10	31.80	35.27	32.24	35.71	33.74
Spring,	47.78	48.77	48.28	54.39	54.55	51.25	53 87	47.90	51.18
Summer,	68.81	70.37	76.81	72 07	71.73	74.91	72.95	73.39	72.63
Autumn,	52.17	54.24	53.69	54.85	54.56	53.29	55.44	55.07	54.20
Winter,	27.64	31.52	30.81	34.23	33.12	33.78	35.38	34.86	32.66
Year,	49.10	51.23	52.40	53.88	53.49	53.31	54.41	52.80	52.66

TABLE II.

Mean daily range of Temperature.

Period.	1836	1837	1838	1839	1840	1841	1842	1843	8 years
January,	11.73	10.40	13.74	14.37	12.36	9.66	11.65	14.23	12.27
February,	16.04	12.12	10.38	12.24	15.71	13.72	12.73	11.63	13.07
March,	17.92	14.52	14.60	14.97	18.06	16.70	14.53	14.56	15.73
April,	18.50	16.81	13.18	22.55	19.55	15.45	15.52	16.53	17.26
May,	20.00	15.39	13.06	19.10	18.42	20.56	19.92	11.79	17.28
June,	12.43	12.28	15.79	17.20	20.56	18.66	16.08	10.71	15.46
July,	12.53	12.42	16.15	17.43	15.61	18.43	14.53	12.71	14.98
August,	11.31	11.34	15.11	12.98	14.47	15.93	14.16	9.84	13.14
September,	9.77	14.72	13.83	13.80	19.53	12.93	16.58	9.92	13.88
October,	12.73	13.98	11.61	14.53	16.95	13.58	20.77	13.61	14.72
November,	11.71	13.93	12.01	12.73	14.02	8.88	13.82	10.33	12.18
December,	10.60	11.98	12.19	9.60	11.40	9.61	8.87	10.27	10.57
Spring,	18.81	15.57	12.61	18.87	18.66	17.57	16 66	14.29	16.76
Summer,	12.09	12.01	15.68	15 87	16.88	17.67	14.92	11.09	14.53
Autumn,	11.40	14.21	12.48	13.67	16.83	11.80	17.06	11.29	13.59
Winter,	12.79	11.50	12.10	12.07	13.16	11.00	11.08	12.04	11.97
Year,	13.77	13.32	13.47	15.12	16.38	14.51	14.93	12.18	14.21

TABLE III.

Greatest daily range of Temperature in each month.

Month.	1836	1837	1838	1839	1840	1841	1842	1843	Average of eight years.
January,	27.5	27.50	25.5	32.50	22.50	19.00	24.00	25.50	25.50
February,	28.5	22.	22.	21.50	34.00	25.00	24.50	27.00	25.56
March,	29.5	26.	24.	30.00	32.50	39.00	33.50	29.00	30.44
April,	32.75	30.	29.	39.00	31.00	31.50	29.00	29.00	31.41
May,	33.50	26.	27.00	31.50	28.00	8.00	30.50	20.50	29.38
June,	27.00	21.50	28.50	28.50	30.00	36.00	31.50	21.00	28.
July,	22.00	18.5	22.00	25.00	24.00	30.00	23.50	22.00	23.38
August,	22.00	22.	24.00	27.00	25.00	23.00	25 50	17.00	23.19
September,	18.50	23.5	32.00	27.00	33.00	21.00	26.00	18.00	24.88
October,	24.00	29.5	22.50	27.00	33.00	24.00	39.00	27.00	28.25
November,	23.5	28.	24.00	23.50	27.50	25.00	24.00	25.00	25.06
December,	33.	26.50	23.00	25.00	25.	32.00	16.00	24.00	25.56

TABLE IV.

Extreme range of Temperature in each month, and in each year.

		1836	1837	1838	1839	1840	1841	1842	1843	Average of eight years.
January,	Max.	48.50	47.5	61.5	56.	50.	61.	56.	66.5	55.88
	Min.	2.50	6.	18.	6.	5.	5.	14.	11.	8.44
February,	Max.	48.	49.5	55.	52.	70.	54.	61.	47.	54.56
	Min.	-7.	10.5	10.	13.	3.	4.	15.	7.	6.94
March,	Max.	53.5	61.	63.	77.	72.	77.	69.	57.5	66.25
	Min.	11 5	7.	18.	16.	20.	21.	26.	15.	16.81
April,	Max.	77.25	79.5	73 5	81.	85.	73.	77.	77.	77.91
	Min.	26.	30.	27.	32.	30.	30.	28.	29.	29.
May,	Max.	87.	81.25	82.	86.	86.	94.	83.	79.	84.78
	Min.	39.	32.	40.	40.	40.	32.	43.	45.	38.88
June,	Max.	88.5	84.	90.	87.5	89.	95.	88.5	87.	88.69
	Min.	48.	53.	50.	49.	47.	51.	42.	42.	47.75
July,	Max.	89.	86.5	96.	92.	90.	97.5	92.5	94.	92.19
	Min.	57.	60.	60.	59.	56.	56.	61.	58.	58.38
August,	Max.	84.5	89.	92.	87.	89.	90.	86.5	85.5	87.94
	Min.	49.	55.5	55.	55.	56.	58.	55.	61.	55.56
September,	Max.	86.	79.5	86.	84.5	84.	88.	86.	86.	85.
	Min.	43.	44.	50.	43.	35.	55.	40.	42.	44.
October,	Max.	73.	77.5	75.	75.	75.	65.	86.	73.	74.94
	Min.	30.	31.	35.	34.	29.	30.	37.	35.	32.63
November,	Max.	67.	70.	64.	58.5	66.	72.	62.	66.	65.69
	Min.	24.	23.	18.	18.	27.	20.	18.	23.	21.38
December,	Max.	56.	62.5	48.	58.5	52.	50.5	47.	49.5	53.
	Min.	10.	19.	10.	14.	14.	15.	15.	15.	14.
Year,	Max.	89.	89.	96.	92.	90.	97.5	92.5	94.	92.50
	Min.	-7.	6.	10.	6.	3.	4.	14.	7.	5.38
	Extreme range.	96.	83.	86.	86.	87.	93.5	78.5	87.	87.12

II.—*Of the Rain.*

The observations on the rain have been, since 1838, confined to the station on the ground, the position of which is described in the second report above referred to. The gauges for measuring the snow, as well as the rain, have been used at this station, and the general results of the observations are given in Table V.

Table VI, shows the number of days in which the quantities of rain and snow, recorded in Table V, have fallen.

Table VII, shows the average quantity of rain which has been received from different quarters of the compass. From this statement it appears, that in the summer season about *one-half,* and in each of the other seasons *two-thirds*, of the whole quantity of rain comes from the N.E.; of the remaining quantity about one-half comes from the S.W.

The slight discrepancies which may be remarked, in comparing the general averages in Tables V and VII, arise from the circumstance that the observations during the last eight months of 1835, (being the beginning of the series,) are included in the averages of Table VII, but not in those of Table V.

The following cases of remarkably heavy rains, which have occurred during the period of these observations, are considered worthy of special notice :—

In 1838, September 12th and 13th, there fell, in 25 hours, 5.174 inches of rain, wind N.E.

In 1840, April 11th and 12th, there fell, in 17½ hours, 3.381 inches of rain, wind S.W.

In 1840, August 12th and 13th, there fell, in 24 hours, 3.137 inches of rain, wind S.W.

In 1841, August 10th and 11th, there fell, in 17 hours, 5.330 inches of rain, wind S.W.

In 1842, July 15th and 16th, there fell, in 13½ hours, 3.179 inches of rain, wind N.E.

In 1843, August 5th, there fell, in 14½ hours, 4.080 inches of rain. wind N.E.

In 1843, August 7th, there fell, in 1 hour, 1.018 inches of rain, wind S.W.

In the city of Philadelphia the fall of rain, on the 5th of August, 1843, was 4.5 inches in 1½ hour, and about Chester, in Pennsylvania, twenty miles south of Philadelphia, the rain was still heavier.

TABLE V.

Quantity of Water fallen in Rain, or Snow, in each Month, and in each Season.

Period.	1836	1837	1838	1839	1840	1841	1842	1843	Mean of 8 years.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January,	5.138	1.745	1.721	4.163	1.886	6.600	1.221	2.056	3.066
February,	2.498	2.809	1.549	2.531	2.808	2.001	3.704	2.146	2.506
March,	1.420	3.425	2.242	1.015	2.304	3.797	2.766	3.921	2.611
April,	3.019	1.969	2.841	1.434	6.649	5.277	4.133	3.471	3.599
May,	1.929	4.351	3.220	5.519	2.086	2.744	4.421	2.132	3.300
June,	7.665	2.814	4.192	3.818	4.723	5.359	3.202	4.157	4.491
July,	1.917	3.677	1.865	2.025	4.704	3.425	8.381	4.276	3.784
August,	2.356	4.579	1.199	4.566	6.352	9.762	3.309	9.048	5.146
September,	1.906	2.228	8.492	2.865	1.970	2.674	1.062	4.780	3.247
October,	2.929	0.569	3.667	2.369	3.765	2.338	1.564	3.484	2.586
November,	2.921	2.386	2.787	3.198	2.360	5.030	2.986	4.186	3.232
December,	3.850	2.367	0.686	5.173	2.549	4.784	3.560	3.319	3.286
Spring,	6.368	9.745	8.303	7.968	11.039	11.818	11.320	9.524	9.510
Summer,	11.938	11.070	7.256	10.409	15.779	18.545	14.892	17.481	13.421
Autumn,	7.756	5.183	14.946	8.432	8.095	10.042	5.612	12.450	9.065
Winter,	11.486	6.921	3.956	11.867	7.243	13.385	8.485	7.521	8.858
Year,	37.548	32.919	34.461	38.676	42.156	53.790	40.309	46.976	40.854

TABLE VI.

Number of Days in which Rain, or Snow, fell in each Month, and in each Season.

Period.	1836	1837	1838	1839	1840	1841	1842	1843	Average.
January,	15	9	9	9	7	14	7	9	10
February,	13	9	8	7	11	7	11	9	9
March,	9	13	10	7	11	11	16	9	11
April,	12	9	10	7	8	19	15	13	12
May,	11	9	17	14	9	15	16	10	12
June,	15	16	8	14	8	13	14	6	11
July,	6	9	6	12	10	7	11	9	9
August,	12	8	3	14	9	11	12	10	10
September,	11	8	9	9	8	7	5	10	8
October,	8	5	8	7	10	9	8	10	8
November,	8	9	7	7	9	14	10	13	10
December,	8	8	7	14	10	11	10	11	10
Spring,	32	31	37	28	28	45	47	32	35
Summer,	33	33	17	40	27	31	37	25	30
Autumn,	27	22	24	23	27	30	23	33	26
Winter,	36	26	24	30	28	32	28	29	29
Year,	128	112	102	121	110	138	135	119	120

TABLE VII.

Average quantity of Rain, or Snow, annually, from each quarter of the compass in eight years.

1836 to 1843	N. E.	S. E.	S. W.	N. W.	Total.
	Inches.	Inches.	Inches.	Inches.	Inches.
January,	2.159	0.394	0.263	0.250	3.066
February	1.936	0.050	0.453	0.068	2.507
March,	2.050	0.165	0.334	0 062	2.611
April,	2.115	0.673	0.479	0.332	3.599
May,	2.160	0.219	0.443	0.355	3.177
June,	2.135	0.512	1.245	0.570	4.462
July,	1.960	0.103	1.515	0.469	4.047
August,	2.043	0.159	1.786	0.864	4.852
September,	2.202	0.248	0.485	0.273	3.208
October,	1.715	0.149	0.257	0.307	2.428
November,	2.076	0.196	0.279	0.639	3.190
December,	2.272	0.219	0.225	0.516	3.232
Spring,	6.325	1.057	1.256	0.749	9.387
Summer,	6.138	0.774	4.546	1.903	13.361
Autumn,	5.993	0.593	1.021	1.219	8.826
Winter,	6.367	0.663	0 941	0.834	8.805
Year,	24.823	3.087	7.764	4.705	40.379

Mr. Austin's Apparatus for Fitting Ships' Boats as Life Boats, in cases of shipwreck, and for raising Sunken Vessels.

Mr. Austin, formerly harbor-master at the island of Heligoland, suggests the following plan as sufficiently simple to be within the reach of every vessel in such emergencies:—

When a vessel is driven on the rocks, sand, or shore, or founders at sea, in getting the boats over the side they are frequently stove alongside the wreck before the tackles can be unhooked, and, even if cleared off the tackles, it too often occurs that they are stoved, swamped, or upset, when brought alongside to receive the passengers and crew. To avoid such calamities, Mr. Austin recommends that every boat, before she is launched over the side, should be fitted as a life boat, with canvas cases on each side, of the whole length of the boat, having a round head at either end marled on to a good hawser, or small chain, and secured round her at light water mark, tautened up by nettles to the gunwale. The cases may be cut out of good topsails, or courses, and made from two to three feet in diameter; another case of lighter cloth of duck, or even of calico, should be made, rather larger in dimensions, and placed within the stout canvas case, each case having three flexible tubes, or pipes, inserted at the bottom part, one near to each head, and one in midships, made of raw hide, India rubber cloth, or several thicknesses of canvas, about a fathom in length, and half an inch in diameter, with a mouth piece, or pipe, to be blown into, and stopped, or corked. The long boat and skiff should be placed on two spars projected over the side, for the purpose

of launching them; the cases, well saturated with water, filled with air, stopped, and the boat launched, with plenty of warp slack under foot, and not brought up with less than half a cable, each boat having only two hands in her when launched, with a line passed round them and stopped to the thwart to bale her out, and to receive the passengers and crew, who should have a smaller similar case placed round each of them.

The boats so fitted would contain, with safety, double the number of persons they could possibly hold under ordinary circumstances, and would not be upset in a heavy sea, and, on going on a lee shore, would hold together and drive well up.

If the weather and sea should admit of the boats being brought alongside the wreck, the cases being filled with air would serve as flexible fenders, and allow her taking in a number of persons to be removed to the other boats.

Raising Sunken Vessels.—According to Lloyd's List, taking an average of three years, not fewer than 557 vessels are sunk, or altogether lost annually.

A vessel having gone down, the first operation is to ascertain her position as nearly as possible, by sweeping with a rope of sufficient length, having two leads fixed thereto, at about sixty fathoms apart, the object of which is to draw the rope along the bottom till it meets with an obstruction. It is easily ascertained, by sounding, whether he obstruction to the progress of the sweeping rope is caused by the vessel, or by an anchor, or other object; if it be the vessel, it is necessary to ascertain the position in which she lies; this is done by again sweeping the vessel with a small working chain, properly buoyed at equal distances, which will show her length and beam. To ascertain if the bowsprit is still standing, it is necessary to sound again at each end of the vessel. The purchase chain is next passed round the vessel, having a sufficient number of collapsed air cases, formed as above described, shackled on to it, and when tautened round her by means of other cases, or purchase lighters, the chain is effectually secured round the vessel by stoppers. The operation of filling the air cases is next proceeded with, which is effected by powerful air pumps on board a steam vessel taken out for the purpose, and as the displacement of the water is going on, the vessel is gradually being raised from her bed, and by the time they are filled she will be above the surface of the water, and ready to be towed to shore by the steamer. Trans. Soc. Arts, &c.

Description of a machine for Blocking Straw Bonnets. By Vincent Price, *of Soho.*

The object of bonnet pressing is to give to the work a finished appearance, after the plait is sewn together.

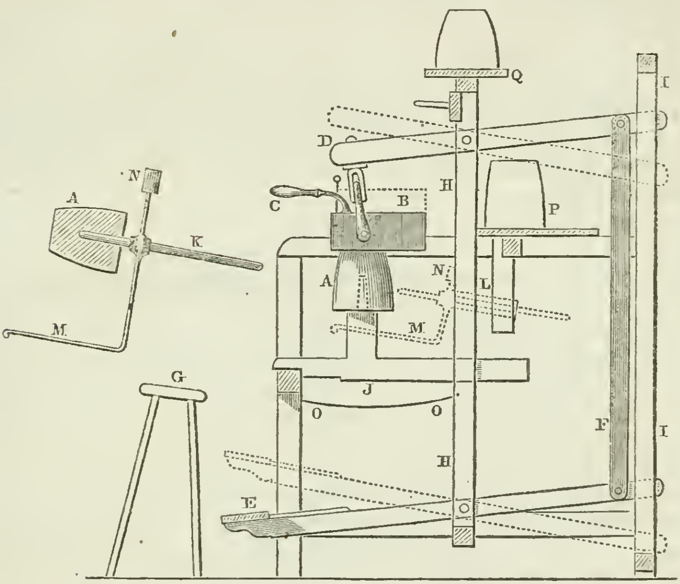
This operation is usually performed by placing the bonnet on a wooden block of the required form, and pressing it with a heated box

iron, a damp cloth having been first applied to it to prevent the material from being discolored.

The blocker increases the pressure of the iron by throwing the weight of his body upon it, a practice frequently productive of serious bodily injury.

The object of Mr. Price's machine is to obviate this serious defect in the ordinary mode of blocking bonnets. The accompanying view exhibits the several parts of the machine.

Fig. 2 Fig. 1.



A, fig. 1, is one of the blocks in a position to receive a bonnet; B, is the box iron, with its handle C, which is hung with double joints and swivel to the lever D, which is connected with the treadle E, by means of the vertical bar of iron F, the weight of which is sufficient to overbalance the box iron B, and treadle E, and raise them up, as shown by the dotted lines.

Instead of standing, as usual, the blocker sits on the stool G, and by his feet on the treadle, lowers the box iron, which he can guide and turn in any direction by its handle C.

The middle upright bars H and I, of the frame are made double, to serve as guides to the lever D, and treadle E, and also to receive the movable cross bar J, which supports the block A. When the sides are to be blocked, the bar J, is lifted out of its place, and the axis K, fig. 2, is put into the metal socket L, shown by dotted lines, fig. 1, the block A, being placed on the end of the axis, as seen in fig. 2. To the axis K, is attached an arm M, which is moved by either hand of the blocker, so that the bonnet may be turned quite round under the iron; the arm has a balance weight N. O O, is a net stretched across

the whole space before the blocker, on which the bonnet may be laid. P and Q, are two shelves on which to place blocks of different sizes.

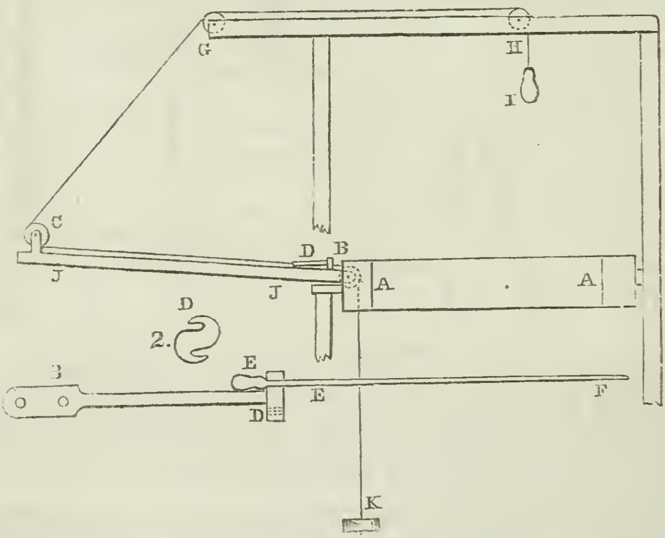
Trans. Soc. Arts, &c.

Description of a machine to draw out Terry-Wire. By John Ferry, *of Bethnal-Green.*

The wires used in weaving terry, or uncut velvet; are usually put in and pulled out of their places by the thumb and first finger of the left hand of the operator, which causes great soreness to the ends of the thumb and finger of the weaver, and continual pain in the left arm. Mr. Ferry's invention is to obviate these inconveniences.

A A, fig. 1, is the breast roll of an ordinary loom. The wire F F, fig. 2, is furnished with a knob E, made of bone, which is caught by the hook D, fig. 3, of the key, fig. 2, instead of by the thumb and finger, as usual.

Fig. 1.



To the end of the key, fig. 2, is attached a cord, which passes over the pulleys C, G, and H, to a lightly weighted handle I, which, being pulled down by the right hand of the operator, draws out the wire in the direction of C, along the inclined plane J J, from which the weaver removes it, ready to draw out the next wire in order; another cord may be attached to the key with a weight K, fastened to it, in order to return the hook from C to D.

Ibid.

Description of an improvement in the Coast Mortar, in use for saving the lives of persons in cases of shipwreck. By Capt. T. M. Bagnold, *of Saxmundham, Suffolk.*

The mortar at present in use for saving the lives of shipwrecked persons, although generally known as Captain Manby's, was really the proposal of Lieut. Bell, of the Royal Artillery, and to him the Society's reward was voted, much about the time of Captain Manby's birth, and Mr. Bell's model being extant in the Society's collection, it may, perhaps, assist the committee in forming their opinion of my proposed improvement.

The mortar, as sent from the laboratory at Woolwich, is so fitted on its bed that the axis of the bore, is, as nearly as possible, at an angle of 45° with the horizon, and if it could be always used upon a level platform, this, its true elevation, would be permanent. But, it will be obvious, that when the mortar is carried in haste, either to a sandy, or shingle, beach, there is no immediate means of ascertaining that it has this due degree of elevation, or that it is, as it ought to be, level in the transverse direction, or in a line at right angles to the direction of the shot; and as all beaches slope more or less rapidly towards the water, this error is of constant, I may say, of invariable, occurrence; hence arises two errors in the flight of the projectile, the slope of the beach detracts greatly from the elevation, thereby shortening the range, and the transverse error causes a lateral deviation in the flight of the shot from the line it was intended to take.

In mortar practice from level batteries, the *elevation* of the piece is ascertained by an instrument called the gunner's quadrant, which, by means of a plummet, shows the true angle; then a gunner's spirit-level being applied across the upper surface of the mortar, at the muzzle a small mark is made, corresponding to the centre of the air bubble. This operation is repeated on the ring near the touch hole, and a chalk line is struck, connecting these two points, which is technically called *the upper line of metal.* The gunner, standing behind the piece, holds up a plumb line, and causes the mortar to be trained until the plumb line in his hand cuts the chalk line on the gun, and the object to be aimed at; the piece is then ready for firing.

The solid platform remaining level, no further use of instruments is required; but it will be seen, that as the firing upon a sandy, or shingly, beach, moves the position of the gun at every shot, and disturbs the loose materials it stands on, fresh applications of these instruments would be required at each discharge; and the Government, well knowing the impracticability of using them in blowing weather, and dark nights, in such exposed situations, have very properly withheld the supply of them.

During the heavy gales of last winter, a brig came on shore about a mile below the town of Aldborough, and every effort was made by the coast-guard and beach-men to save the crew. The wreck was barely 200 yards from the beach; the men deceived by the slope,

every shot fell short. Increased charges were then tried, the result of which was the regular breaking of the rope at each fire, and the loss of the shot, and part of the line.

These circumstances induced me to turn my attention to the subject, and I flatter myself I have succeeded in fitting to the mortar *a simple, cheap, and efficacious means, which, in the first place, enables the most unpracticed person to ascertain the true elevation and transverse level of the gun in an instant, even in the darkest night, and to correct them with the greatest ease under any circumstances of the weather, or situation.*

My improvement has another very considerable advantage attached to it, viz., as the proper elevation and level can be given to a certainty without the use of instruments, *the upper line of metal, or line of direction, on the gun, becomes* PERMANENT, and is, therefore, *painted with white upon the piece*, instead of being found and struck each time upon it with chalk; so that the three operations of elevating, leveling, and pointing, are reduced to a single observation, whereby much valuable time is saved where a wreck is in momentary danger of going to pieces, or the sufferers rapidly sinking under cold and exhaustion.

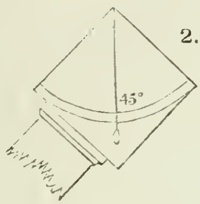
Captain Wheatley, R. N., the Inspecting Commander of the Coast-guard here, is so pleased with the plan, that he is about to apply it to the two other guns under his charge on this coast, and will report in its favor to the Board; if adopted by them, the apparatus will, in future supplies, be fitted at the Arsenal; but to those at present in use it may be applied by any village blacksmith, premising that a gunner's level must be used in the fitting, which might be passed from station to station round the coast in the usual times of communicating; a quadrant may be made by any carpenter sufficiently accurate for the object in view; indeed, any level would answer the purpose, if fixed for temporary use, as shown in fig. 3.

The mortar, on its bed, with the wedge in its proper and fixed position, is to be laid on a table, bench, or on the ground, if *nearly* level; the quadrant being applied to the gun, and wedges, stones, or pieces of wood, are to be placed under the *fore*, or *hind*, part of the bed, as required, until the quadrant shows an elevation of 45°. A chalked plumb line is next hung down the *side* of the bed, and the perpendicular line struck upon it; this line is to be well cut into the wood, say a quarter of an inch in depth, and of the same width, and the groove painted white. A small iron pendulum, having been previously prepared, is to be hung, by means of a screw driven into the wood, in such a position that its fiducial, or chamfered, edge should be in a perpendicular position, and close by the side of the groove. The level is next to be applied in the transverse direction of the bed, and the lower side raised as required, as the end was raised in the previous operation; the plummet being hung down the *back part* of the bed, the line is to be struck and cut into the wood, and the pendulum, &c., fixed as before.

Whilst the gun is in this position, the level is to be applied to the

muzzle and base rings, as previously mentioned, and the true upper line of metal being found, is to be *painted* on the mortar.

Fig. 1, shows the mortar on its bed, at an elevation of 45° by its wedge, or quoin. The grooves A A, and B B, and pendulums C and D, with their guard irons E E, are shown at the side and train of the bed. The former of these shows the correct elevation, and the latter proves the painted line F, on the upper surface of the gun, to be in a plane vertical to the horizon, and passing through the axis of the bore. Any deviation from inequality of ground is immediately detected by one, or both, pendulums.



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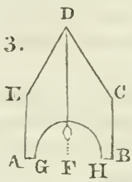


3.

Fig. 1.

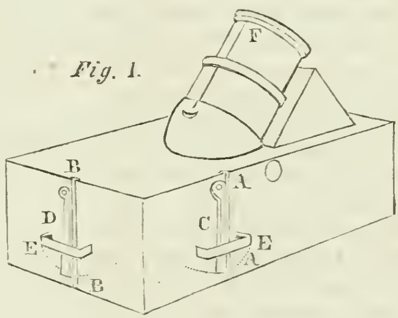


Fig. 2, shows a temporary quadrant, made from a rectangular piece of board, the plummet hanging on a line bisecting the arc, whilst one edge of the board being kept against the muzzle of the piece, gives the elevation at 45°.

Fig. 3, shows a temporary level. Let A B C D E, be a piece of thin board, and D F, a line marked on the board, perpendicular to A B. A semi-circular opening being made at the bottom of the board, the points G H, are applied to the rings of the gun, and passed right and left (the board being held vertically,) until the pointed plummet touches the metal, and its suspending string covers the line D F.

These temporary instruments form no part of the proposal, but are merely inserted to show with what facility the mortars, now in use, can be regulated by tools within the reach of the humblest mechanic.

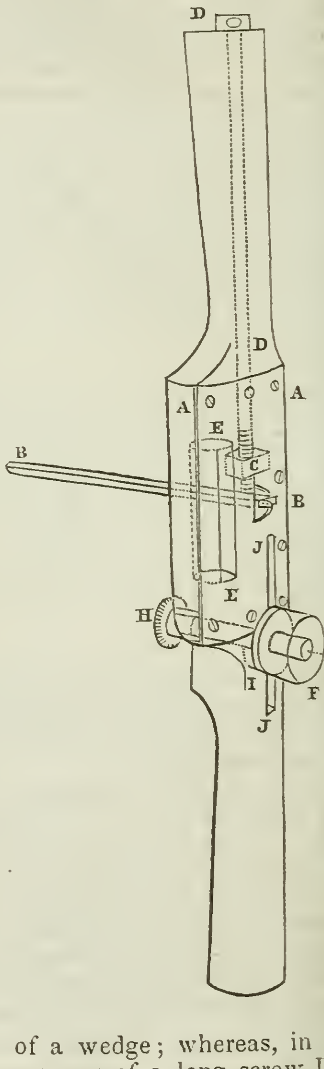
Ibid.

Description of an Improved Coach-makers' Fence-Router. By William Middleton.

The fence-router is a tool used by carriage builders for cutting out

the grooves in the framing of a coach body, into which are let the edges of the various panels.

The width of the groove is determined by the size of the cutting iron, and its distance from the edge of the framing is regulated by an adjustable iron fence. In the ordinary router the fence is fixed by two stop screws passing through a slot in the tail-piece of the stock, so that the fence may be adjusted to the required distance from the cutting iron; and the face of the fence is slightly curved, in order that the tool may work more freely in cutting out grooves in curved portions of framing.



Mr. Middleton's chief improvement is the substitution of a rolling fence F, for that ordinarily used, of which G H, is the axis; a slot J J, is formed in the stock which admits of the axis G H, of the roller being placed in a position parallel with the cutting iron. The fence, when adjusted to the required gauge, is secured by a milled-headed nut H, screwed on the upper end of the axis, and bearing on a collet by which pressure is transmitted to the surface of the wood; the counter-pressure is on a circular flanch I, of the same diameter as the roller fixed on the axis, and bearing on the iron face of the router. In order to prevent the fence turning in the slot, a square flanch is fixed to the other end of the axis; the friction on the working face of the router A A, is reduced by a roller E E, being let into the stock beneath the iron face A A, a small segment of which projects beyond the face through an opening formed therein.

Another improvement effected by Mr. Middleton, is the method of fixing the cutting iron B B, which is ordinarily done by the introduction of a wedge; whereas, in this improved router it is secured by the pressure of a long screw D D, passing from the left end of the stock quite through one arm thereof, to the cutting iron B B, and furnished with a nut C.

Ibid.

On the Preparation of Artificial Yeast. By Geo. Fownes, Ph. D.

It often becomes a matter of great practical importance to have it in our power to excite the vinous fermentation under circumstances in which ordinary yeast cannot be obtained. In making bread, for example, although the use of yeast may be avoided by employing what is called "leaven," or dough which has already become sour, and partly putrefied by spontaneous change—a practice which has been followed from the most remote antiquity, and is still occasionally in use—the bread so made is always to be distinguished by a peculiar sour and nauseous taste and smell, and can never bear comparison with that fermented by yeast.

The object of the present notice is to point out a method by which yeast of the most unexceptionable quality can be artificially produced at will. I am aware that some substitute for ordinary ferment in brewing has long been known to certain persons, who go about the country and impart their secret to those who are willing to purchase it: of the nature of this preparation I am ignorant, and a reference to systematic chemical works will suffice to show that whatever it be it has never been made public.

On turning to Berzelius, it will be found stated,* that although the reproduction, as it were, of yeast, the conversion of a small into a large quantity, is a very easy thing, yet to produce that substance from the beginning is very difficult. He describes a process for this purpose on the authority of Dr. Henry, and which consists in taking a strong infusion of malt, saturating it with carbonic acid, and then exposing it for some days to the proper fermenting temperature, when a small quantity of yeast is gradually formed and deposited, which may, by various contrivances, be made to give origin to a larger. I shall have occasion to notice presently the behavior of a malt infusion when left to itself at a temperature of 70° or 80° F. for some time, and to show that the addition of carbonic acid is wholly unnecessary.

The principle of induced chemical action, which Liebig has assumed to explain a great number of those extraordinary phenomena to which Berzelius gave the term "Catalysis," and which principle has been so fully confirmed, and even, perhaps, extended by the late valuable researches of MM. Boutron and Frémy, on the formation of lactic acid, serves to solve this difficulty, as it will doubtless many others of far greater magnitude and importance. It has been shown that "the kind of chemical change going on in the decomposing azotized body of ferment, determines the kind of decomposition which shall occur in the neutral ternary substance, subject to its influence:" that diastase, for example, according to its peculiar condition, whether fresh from the germinated grain, slightly putrefied, or in a still more advanced state of that change, possesses the singular power, in the first case, of changing starch into dextrin, and ultimately into grape

* Lehrbuch, vol. viii, p. 89, foot note, third edition.

sugar; in the second, of causing the conversion of sugar into lactic acid; and in the third and last, of exciting the vinous fermentation.

Now if common wheaten flour be mixed with water to a thick paste, and exposed, slightly covered, to spontaneous change in a moderately warm place, it will be observed to run through a series of changes, which seem very closely to resemble those described by MM. Boutron and Frémy, in the case of diastase.

About the third day of such exposure it begins to emit a little gas, and to exhale an exceedingly disagreeable sour odor, much like that of stale milk; after the lapse of some time this smell disappears, or changes in character, the gas evolved is greatly increased, and is accompanied by a very distinct and somewhat agreeable vinous odor; this will happen about the sixth or seventh day, and the substance is then in a state to excite the alcoholic fermentation.

A quantity of brewers' wort is next to be prepared in the usual manner, by boiling with hops; and when cooled to 90° or 100°, the decomposed dough, before described, after being thoroughly mixed with a little tepid water, is added to it, and the temperature kept up by placing the vessel in a warm situation. After the lapse of a few hours, active fermentation commences; abundance of carbonic acid, having its usual agreeable pungent smell, is disengaged, and when the action is complete, and the liquid clear, a large quantity of excellent yeast is found at the bottom, well adapted to all purposes to which that substance is applied.

In one experiment the following materials were used:—a small handful of ordinary wheat flour was made into thick paste with cold water, covered with paper, and left seven days on the mantel-shelf of a room where a fire was kept all day, being occasionally stirred; at the end of that period three quarts of malt were mashed with about two gallons of water, the infusion boiled with the proper quantity of hops, and when sufficiently cooled, the ferment added. The results of the experiment were a quantity of beer, not very strong, it is true, but quite free from any unpleasant taste, and at least a pint of thick barm, which proved perfectly good for making bread.

It appears to me that this simple plan would enable distant residents in the country, and settlers in the colonies, to enjoy the luxury of good bread when a little malt could be got—a very easy home manufacture from grain of any kind; the hops might probably be omitted when the yeast alone was the object.

A moderately strong infusion of malt which has not been boiled, suffered to stand in a warm place for some days, speedily becomes sour and turbid, and begins to evolve gas; this change rapidly progresses, carbonic acid is given out plentifully, and a deposit of thick insoluble whitish matter formed, which readily excites fermentation in a dilute solution of sugar; the supernatant liquid contains alcohol, acetic acid, and, I believe, lactic acid.

When wort, which has been boiled and hopped, is set aside to decompose spontaneously, the change it undergoes appears to depend very much upon its strength. When weak, three or four days elapse before anything is noticed; a scum then collects upon the surface, and

a brown flocculent substance is thrown down, which is incapable of exciting fermentation in a solution of sugar, while the liquid gives off a flat, offensive smell. If the infusion experimented on be stronger, then the change is different; the liquid becomes turbid from the separation of a yellowish adhesive substance, a good deal of gas is very slowly emitted, alcohol is formed, and the deposit at the bottom of the vessel proves a pretty active ferment to sugar. The acidity of the liquid is but trifling, and its smell is somewhat disagreeable. These differences in the behavior of boiled wort may also depend upon the quantity of hops added, and the length of time during which the ebullition had been continued.

The effect produced in a spontaneously fermentable liquid by vegetable acids, or acid salts, such as cream of tartar, is a curious subject of inquiry. From an experiment made upon some wort, it appeared not improbable that the result of such addition showed an interference in the formation of lactic acid. We know that when the juice of grapes, or currants and gooseberries, is exposed to the air, the vinous fermentation is set up apparently at once; whereas in an unboiled infusion of malt, which is destitute of these substances, lactic acid seems to be first formed, although ultimately the two fermentations go on together.

I stated, when speaking of the spontaneous decomposition of wheaten dough, that an acid state preceded that in which it became an alcoholic ferment; and if in this condition it be mixed with a dilute solution of common sugar, and the whole kept warm for several days, it furnishes a sour liquid which is rich in lactic acid, and from which white crystalized lactate of zinc is easily prepared. There is a tendency in the liquid to run into the alcoholic fermentation, and to produce vinegar by a subsequent change, but still the quantity of lactic acid so formed is very considerable.

Common wheat-gluten then in its mode of decomposition strikingly resembles diastase; like that substance it runs in succession through two different dynamic conditions; it is successively a lactic acid, and an alcohol ferment: is it too much to expect that it might, by proper means, be detected in a third condition, namely, as a "sugar ferment," like diastase itself in the state in which it exists in malt? Is it not possible that diastase, as a definite proximate principle, has no more existence than yeast; that its powers are purely dynamic, and that it is, in short, nothing more than the gluten of the seed in one of its earliest stages of decomposition? This is an interesting inquiry, but its prosecution will be somewhat difficult, from the rapidity with which these changes succeed each other; it must be remembered that no one has yet succeeded in getting diastase in a state fit for analysis.

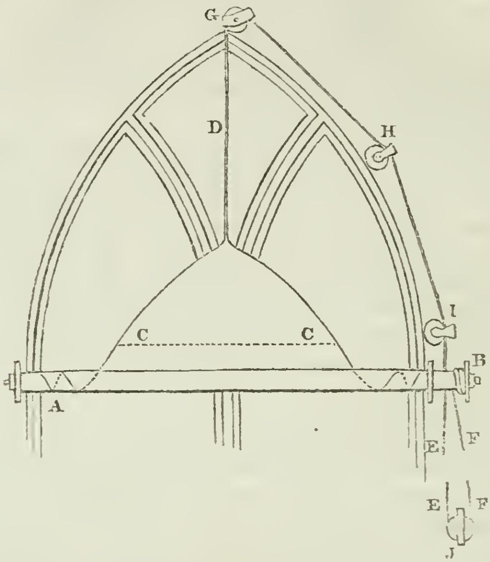
Mem. Lond. Chem. Soc.

Description of an Improved Gothic Window-Blind. By Mrs. Jemina Goode.

The ordinary method of fixing blinds for the upper parts of Gothic windows, is to attach the material of which the blind is composed, to

a frame of wood of the required form, which frame is fixed to that part of the window by screws, or otherwise.

The principal inconvenience of this plan is that, when not required to shade the sun, the blind cannot be drawn up, but remains fixed, and thus darkens the apartment in which it is used.



In order to obviate this defect, Mrs. Goode proposes to fix the roller A B, to which the holland, or other material, C C, is attached, across that part of the window where the contraction of the frame begins, the holland, or other material, being cut into the required shape, and the broad part being fixed to the roller A A. By attaching a line D, to the pointed end of the blind, and passing it over the pulleys G H I, fixed in the upper, or curved, portion of the frame, and thence round the pulley J, towards the bottom of the frame, and returning it to the roller to which it is secured, the blind is readily pulled up, or down.

To keep the blind in shape, wire stretchers may be sewn in across the holland, or other material, used for the purpose. The blind described above is the simplest of the two patterns sent.

Trans. Soc. Arts &c.

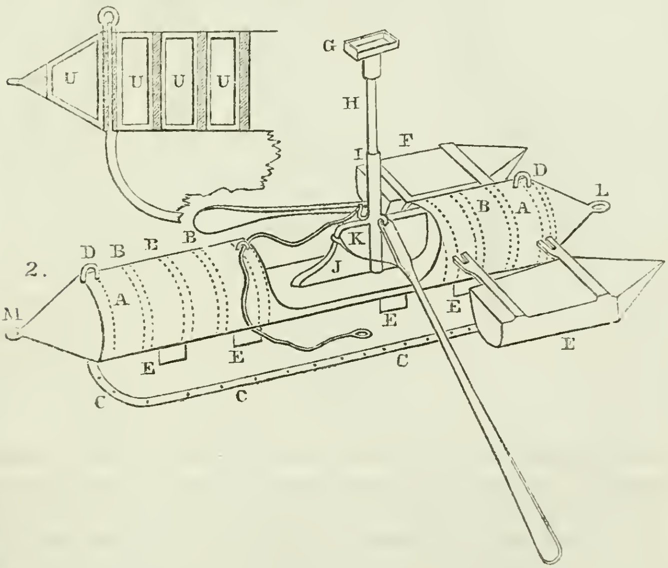
Description of an Improved Life-Buoy. By Com. Beadon, *R. N.*

Fig. 1, shows the buoy as it would appear when afloat. Fig. 2, a longitudinal section of part of the main float; and fig. 3, the mode of suspending the buoy at the stern of the vessel, and of letting it go when required.

The buoy is a cylindrical tube A A, made either of copper, or

sheet zinc, eight feet in length, and twelve inches across at its greatest diameter, each end being tapered off to a point, and furnished with eye-bolts L M, for the double purpose of attaching a rope, and of steadying it when suspended at the stern of the vessel by the eyes passing over guide-rods, one of which N, is shown in fig. 3; O O, in the same figure being arms to support the blades of the oar. The buoy, when suspended at the stern of the vessel, is kept in its place by a chain P, passing round under it to the hook Q. The sliding bolt R R, supports the hook Q. When it is required to lower the buoy, it is only necessary to raise the bolt by pulling the string S, the chain is released thereby, and the buoy drops into the water. C C C, the keel, which is from 10 to 12 inches in depth, and constructed of two pieces of bar iron, about $\frac{7}{8}$ inch by $\frac{3}{4}$ inch in size, having sheet metal riveted between them, and which is secured to the main float A A, by rivets passing through proper knees E E E. The ends of the iron binding of the keel C C C, are turned up, and, passing through the cylindrical main float, are secured to the rings D D.

Fig. 1.

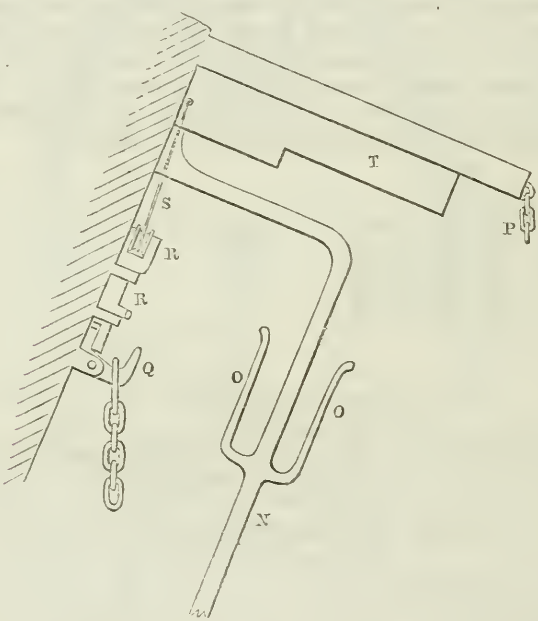


The main float is rendered stiffer and more secure by being divided into several compartments, which are separated from each other by wooden disks B B B, fig. 1. In these compartments are introduced metal drums, or vessels, U U U, so that, if by an accident to the outer coating of the buoy, leakage takes place, there is still the drum left entire, and filling the particular compartment. This is a very important feature in the invention, and particularly worthy of notice.

A saddle for a man to sit securely on the buoy, is formed in the central part of the main float, as seen in fig. 1; and in order to

strengthen this part of the buoy, a vertical partition J, is introduced, which also serves as a support for the cylindrical case I, in which the tube H, works up and down as occasion may require, and having a spiral spring at its lower end to keep it erect when the fuze-box G, is in use. When the buoy is suspended at the stern of the vessel, the fuze-box is kept dry by being pressed close under the cap T. The oars are hung to the cylindrical case I, by means of a collar surrounding it, to which are attached secure eye-bolts. A line K, is secured to each oar to prevent it from going too much in advance.

Fig. 3.



In order to give the buoy stability when in use, a pair of wings, or outriggers, F F, are hung with stop-hinges to the fore end of the main float, which are secured by bolts passing into two of the wooden disks B B. The outriggers are formed of semi-cylindrical vessels, having semi-conical fore ends. The stop hinges prevent them rising above the proper level, but when not in use they hang down close to the keel. Ibid.

On Eel-Skin Bands and Ropes. By Mr. Joseph Williams.

I have used eel skin upwards of twenty years, for drilling holes for pearls and diamonds, by which means I have a knowledge of its utility. I have tried whip cord, which will not last an hour; I have tried also cat gut, and that indeed is very little better. An eel-skin cut in three or four pieces of the same size as the gut, or string, will

last for three or four months certain, which shows the little wear to which it is subject. I have had them on the shelf for from six to twelve months, in the dusty shop, till they have been quite hard, yet they are as good as ever. When first I thought of weaving eel skins, it appeared to me that it would answer for the Blackwall Railroad, as their rope was always wearing out; and had I the means I should have made a long piece, for it may be made of any length by splicing the skins. I am convinced it would answer their purpose, as it wears so little, and would, I think, last for months with but few repairs. I have never sent any thing to your Society before: my business is that of a goldsmith and jeweller. Ibid.

Lord Rosse's Telescope.

At a meeting of the Belfast Natural History Society, the steps by which difficulties were overcome in making the speculum, were explained by Mr. Stevelly in detail, under the following heads:—

Metal for the Speculum.—The metallic alloy for the speculum consists of four atoms, or chemical combining proportionals of copper to one of tin, or by weight 126.4 copper to 58.9 tin. This alloy, which is a true chemical compound, is of a brilliant white lustre, has a specific gravity of 8.811; a twelfth of a cubic foot, or 144 cubic inches of it, weighing, therefore, a little over 45¾ lbs. avoirdupois, or to allow for all waste, when casting, 50 lbs., which is the rule by which Lord Rosse estimates the weight of metal he requires. This alloy is nearly as hard as steel, and yet is almost as brittle as sealing-wax. Of this most unpromising material Lord Rosse has cast, ground, and has ready for polishing, a circular mass 6 feet in diameter, 5¼ inches thick, and weighing upwards of three tons, with a surface perfectly free from crack, or flaw, and quite homogeneous. The next head is

Casting.—On the first castings having flown into pieces, finding that the fragments no longer fitted each other in their former places, he perceived that they had been in a state of violent strain, arising from the cooling and setting of the outer parts, while the inner parts, yet fluid, were also largely expanded by the heat; this, and the porous surface, led him, by many stages and trials, to the remedy, which is simple and complete. The bottom of the mould is made of a ring of bar iron, packed full of slips of iron hoops set on their edges, which lie in parallel chords of the ring. These, though packed very tightly together, and so closely fitting that the melted metal cannot run between them, yet allow any air that is carried down to the bottom of the mould when the metal is cast in, to pass out through the interstices. After the ring is packed, it is secured in a lathe, and the face, which is to be the bottom of the mould, turned true to the convex shape to fit the concave speculum required. It is then placed flat on the ground by spirit levels, between the furnace in which the metal is melted, and the annealing oven, and the mould completed at the side with sand, in the way practiced by founders, but left open at top. The metal is then melted in cast-iron crucibles; wrought-iron would

be corroded by the speculum metal, and injure its properties, while fire clay crucibles will not answer. Unless the crucibles be cast with their bottoms downward, they will be porous, and the melted alloy will run through their fine pores. When the metal is melted, and still much too hot to pour, the crucibles are brought by a crane, and set firmly, each in a strong hoop iron cradle, which turns on gudgeons, and so arranged round the mould, that when the handles of the cradles are depressed, they pour out their molten mass direct into the mould. An oxide forms rapidly on the surface of the metal while too hot—this is as rapidly reduced back to the metallic state by constantly stirring it with a pine rod; as the temperature sinks the instant this reduction of the oxide begins to cease, is seized on as the proper moment for pouring. The liquid mass descends with a few fiery splashes, and after waving back and forward for a few seconds, the surface becomes still. The setting process begins at the hoop-iron bottom, where a thin film first sets—the process extends upwards in horizontal layers, and at length the top, though red, becomes fixed in form; the mass is then as tough as melting glass, and being turned out of the mould upon a proper truck, with the face upwards, is drawn into the oven to undergo the process of

Annealing, or very slow cooling. Here it is built up into the oven previously heated red hot, and fire is kept up under the floor of the oven for some days; the under fire places are then stopped, and all left for weeks to cool down to the temperature of the air. The six feet speculum was left here sixteen weeks. Here the particles of the alloy slowly arrange themselves into the arrangement in which the aggregating forces are in equilibrium, or natural and equal antagonist tension. When the oven is opened, the speculum is removed to the workshop, to undergo the process of

Grinding, which process was illustrated by working a model. In the workshop it is placed on a circular table, in a cistern filled with water, of temperature, say 55° Fahrenheit, with the face to be ground upwards. The circular table is turned round by the motion of the grinding engine. But first, the edge is made truly cylindrical by being surrounded by many pieces of deal board set in an iron ring pressing against the edge; emery being introduced as it turns round, soon grinds it cylindrical; it is then placed in the box in which it is to be used; here it is firmly secured by a ring of iron brought to embrace, firmly yet gently, its now truly cylindrical edge. The box and speculum, with the face to be ground placed upwards, is now again placed on the circular table in the cistern of water. Emery and water being placed upon it, the grinding disk is laid on, which is a cast-iron plate turned at one surface to the shape to fit the speculum when ground, grooved on that surface with many annular grooves concentric with the plate, and with many straight grooves running across it at right angles to each other. The back of this grinding plate is ribbed with six, or eight, radial ribs, to give it stiffness. This plate sits rather loosely in a ring of iron a little larger in diameter, which is driven back and forward by the motion of the steam engine. This ring has two motions, longitudinal and transverse. The engine causes it to

make $24\frac{1}{2}$ strokes, for one turn of the speculum on its axis under the grinding disk, about 80 strokes taking place in a minute; the length of this stroke is one-third of the diameter of the speculum. The motion is produced by an eccentric pin. The transverse stroke takes place 1.72 times for each turn of the speculum, and its extent is, at the centre of the speculum, $\frac{27}{100}$ of the diameter of the speculum; it is produced by an eccentric fork. A fourth motion takes place by the grinding disk, while, for an instant, free of the ring, at the turn of the eccentrics, being carried round a little by the speculum, on which it is then lying, as it were, free; this causes it to turn once for about 15 turns of the speculum. Emery and water being constantly supplied, the surfaces of the grinding disk and speculum, in a few hours, grind each other truly spherical, whatever be their original defects of form. The process is finished, when, upon drawing off the grinding disk with one steady long pull, the surface of the speculum is left every where uniformly covered with the fine emery arranged in uniform lines, parallel to the line in which the disk was drawn off. A slight polish being now given to the speculum, its focal length is tested by a very simple process. The floors of the loft above the workshop, in the tower of the castle, contain trap-doors, which are now opened, and a mast erected on the top of the tower, which carries at its top a short cross-arm, to the under surface of which a watch dial is fastened, the face of the dial looking down on the speculum, now directly under it, and at a distance of 97 feet. A temporary eye-piece erected in the upper floor of the tower, soon finds the place of the faint and still imperfect image of the watch dial, the proper place of which is a matter of simple calculation, if the speculum be ground to the expected focus. If it be found incorrect, the grinding disk is rendered a little more flat, or a little more convex, and the grinding process is renewed, and so on, until the spherical face of the speculum is given its proper length of radius. When this is accomplished, the brilliant reflecting surface, and true form for producing a good image, is given to the speculum by the final process of

Polishing.—In this, two matters require attention, the polishing powder, and the surface of the polisher. The powder used by Lord Rosse, is not putty, or oxide of tin, as used by Newton and his followers, but red oxide of iron, procured by precipitation from green vitriol, or sulphate of iron, by water of ammonia; this is to be heated carefully in an iron crucible, for it has a tendency to take fire, and thus run many particles into one, and render the polishing powder too coarse. The surface of the polisher used by Newton, was pitch in a very thin layer. Instead of pitch, which Lord Rosse found too full of gritty impurities, he uses rosin tempered with spirit of turpentine. A large quantity of rosin being melted, the spirit of turpentine is poured in, and well mixed and incorporated (about a fifth by weight suffices.) The proper temper is known by taking up a little on an iron rod, and putting it into the water until it acquires the temperature, say of 55° Fahrenheit. Then if the thumb nail make a slight but decided impression, it is rightly tempered; if not, more rosin, or more spirit of turpentine, is added, until the proper temper is attained. The tem-

pered rosin is now divided into two parcels: to the one parcel a fourth part (by weight) of wheaten flour is added to give it tenacity, and diminish its adhesiveness. This is incorporated by stirring, until it becomes clear. To the other parcel an equal weight of rosin is added, which makes it very hard. Upon this, when cooled to 55°, the nail will scarcely make an impression. The grinding disk, with its spherical surface turned upwards, is now heated by fire underneath, and the rosin rendered tenacious by flour laid on with a brush in a thin even coat, at about 150° Fahr. This coat and the grinding disk are then allowed to cool down to about 100° Fahrenheit, when a thin coat of hard tempered rosin is laid on as evenly and thin as possible. The smooth, ground, concave speculum is now covered with a creamy coat of the fine polishing powder and water, and the warm polishing surface turned down upon it at about 80° Fahrenheit, when it soon takes the form of the speculum as in a mould; care must be taken not to put on the polishing plate too hot for fear of cracking the speculum, which the interposed creamy polishing powder helps to protect; nor too cold, else it will not take the proper figure. The grinding engine now gives the same motions to the polishing plate as before, but its weight is much diminished by counterpoising it. The soft tenacious coat below, and the grooves on the surface of the grinding disk, permit the proper lateral expansion, while the hard outer coating retains its form, and holds firmly embedded the particles of polishing powder. The polishing now proceeds rapidly, and as soon as what is technically called the black polish is attained, the defining power is judged of by examining the minute divisions of the image of the watch dial, under an eye-piece of high power. The true form is known to be given as the polishing proceeds, if the focal length slowly increases in a tabulated proportion to the time. The six foot speculum it is expected will be finished after six hours' polishing. Civ. Eng. & Arch. Journ.

Messrs. Young and Delcambre's Type-Setting Machine. By the SECRETARY *of the Society of Arts, &c.*

It may be well to give a short explanation of the ordinary mode of setting up type, before describing the mechanical contrivance for the same purpose, by Messrs. Young and Delcambre.

The various letters and figures to be used in any composition, are arranged in trays technically called cases. These cases have small compartments, or boxes, differing in size according to the recurrence of the letters; thus e, the letter most used, requires the largest compartment. The boxes next in size are for the letters c, d, i, m, r, t, and u, and so on. The type-case stands upon a sloping frame of sufficient elevation for a man of ordinary height to pick out the letters, or types, from the various boxes. This person is called a compositor, and holds in his left hand what is called a composing stick. In this composing-stick, or metal trough, (the length of which is adjustable to serve for lines of every length,) he places the letters, and the vari-

ous spaces, quadrats, &c., which separate the words. It must be borne in mind that the same person who composes the type also justifies the page, that is, leaves it in a fit state to go into the printing-press, by adjusting each line to the exact length required for the width of the page on which he is engaged.

When the composing-stick is filled with eight or twelve lines of type, the mass is removed to, and placed upon a galley, or long tray, and the compositor again sets about refilling his stick. Of course, to make up a sheet it requires a number of pages, the arrangement of which is called imposing. But it is not here required to explain the operations of the printing office further.

The upper part of Messrs. Young and Delcambre's machine consists of the type-reservoirs, or grooves, each of which is $\frac{3}{15}$ths of an inch in width, and of a depth equal to the length of the type, or nearly one inch.

These reservoirs are placed in a slightly inclined position, to prevent the letters from falling out, the longest reservoirs in use correspond with the largest compartments of the ordinary compositor's case already noticed.

Immediately below the reservoirs are as many levers, or cutters, the use of which is to cut off, or displace laterally, the bottom letter of each column of type. The cutters are worked by vertical steel rods, which are connected with the keys in front of the machine, and which latter are similar in appearance to the keys of a piano-forte.

The movement to effect the displacement of the types is one of the most beautiful contrivances in the whole apparatus. By pressing on any one of the keys, its vertical rod is drawn down, and the button at the top of the rod is pressed against the side of the contiguous lever, or cutter, which is moved laterally and horizontally on a pivot; and the lever pressing against the lowest letter of the superincumbent column of type, pushes it through a lateral aperture, just as wide as the thickness of one type, which, thus liberated, is placed at the top of an inclined plate, extending throughout the width of the machine at the back, and runs down a curvilinear track, or groove, to take its place next to the type previously sent down.

The inclined plate is constructed of brass, and contains several tracks, or channels, down which the letters glide at intervals, regulated by the manipulation of the performer. The first curvilinear channel to the right hand serves for the letters a and b, the second for c and d, and so on, as the letter a is pushed towards the right hand, and b towards the left, so as to make each channel serve for two kinds. The forty-eight channels, therefore, serve for ninety-six kinds of type, and all the channels lead into each other in a serpentine manner, somewhat as in railway tracks, or the tracery of Gothic architecture, so as to converge into one single outlet at the bottom of the incline. These curvilinear channels are of equal length from the many points of delivery at the top of the incline, to the one single point of discharge at the bottom of the same, so that the types descend in equal times, and in the exact order in which the piano-forte keys are depressed.

At the point of discharge is an eccentric movement, worked by a treadle, to regulate the admission of the stream of type into a long open trough, or channel, leading to the composing-stick, which is situated, as it were, at the end of the galley containing the column of the composed matter. The assistant slides so much of the long stream of type into the composing-stick as will well form one line; the requisite spaces are then adjusted to make the line of the exact length, and, by a lever movement, the bottom of the composing-stick is withdrawn, which deposits the line of type on those previously set up in the galley; and lastly, the long column of type, as that of a newspaper, is made up into pages as usual.

In this apparatus there are altogether ninety-six keys, of which seventy-two correspond with small Roman letters, figures, stops, &c., and the remaining twenty-four with the small-caps, or capitals, which have reservoirs apart from the rest, and which are placed in the back of the machine.

When in full work as many as 8000 letters, &c., have been set up by this machine in an hour, whereas, by the ordinary mode, a good compositor can, on the average, only set up about 1700 letters in the same time; the wages paid in each case being nearly the same amount. Trans. Soc. Arts, &c.

On Simms' Self-Acting Circular Dividing Engine.

At a recent meeting of the Astronomical Society, Mr. W. Simms read a description of his Self-Acting Circular Dividing Engine. In its general arrangement and construction, it is very similar to that made by Mr. E. Troughton, though there are several additions and peculiarities, which are pointed out. The circle, or engine plate, is of gun metal, forty-six inches in diameter, and was cast in one entire piece, teeth being ratched upon its edge. The centre of the engine plate is so arranged that it can be entered by the axis of the instrument to be divided, and the work, by this means, brought down to bear upon the surface of the engine plate, which arrangement prevents the necessity of separating the part intended to receive the divisions from its axis, &c., a process both troublesome and dangerous. Upon the surface, and not far from the edge of the engine plate, are two sets of divisions to spaces of five minutes, one set being in silver, and the other strongly cut upon the gun metal face. There are also as many teeth upon the edge as there are divisions upon the face of the engine plate, namely, 4,320, and, consequently, one revolution of the endless screw moves through a space of five minutes. The silver ring was divided according to Troughton's method, with some slight variations. In this operation it seemed to the author the safer course to divide the circle completely, and then to use a single cutter for ratching the edge; and he believes that the teeth upon the edge have been cut as truly as the original divisions themselves. Another important arrangement is, that the engine is self-acting, and requires no personal exertion, or superintendence, nothing being necessary but

the winding up of the machine, or rather the raising of a weight, which, by its descent, communicates motion to the dividing engine. The machinery is so arranged that it can be used, or dispensed with, at pleasure, there being some cases in which a superintending hand is desirable. The author then proceeds with a description of the machinery, as represented in the drawings accompanying this paper; and draws attention to the contrivance by which the engine can discharge itself from action when it has completed its work. He concluded by observing, that the machinery is simple, by no means expensive, can be made by an ordinary workman, is adapted to all the engines now in existence, which are moved by an endless screw, lessens the labor of the artist, and increases the accuracy of the graduated instrument. Glasgow Mech. & Eng. Mag.

Efficiency of Iron Vessels.

As a proof of the efficiency of iron vessels, we have received the following testimony, in a letter from Captain Beckett, commander of the iron steam ship Troubadour, dated Liverpool, 22d Sept., 1843; addressed to Messrs. Thomas Vernon & Co., iron ship builders, Barrack street, Liverpool.

"*Gentlemen,*—In reply to your inquiry respecting the iron steam ship Troubadour, which was built by you about two years ago, I beg to state, that having had the command of her ever since she started running regularly between this port and Bristol, I have paid particular attention to her capabilities as regards sailing, strength, and carrying of cargo, and have great pleasure in stating that she is a most excellent sea-boat, and of surprising speed considering the power of her engines.

"I have frequently had on board of her upwards of 300 tons dead weight of cargo, and take the ground on every trip at Swansea, yet I cannot find out the least appearance of straining. I have not, in a single instance, had any occasion to use the pumps, the vessel not having made one drop of water, though often severely tried in the roughest weather. I have lately had her in the graving dock, when I examined her bottom very minutely, and was astonished to find her perfect in every part, not the slightest appearance of corrosion any where, and every plate, rivet, and fastening, as good as the first day she left your hands. I remain, gentlemen, yours truly,

James Beckett."

Ibid.

Longest Wire Rope.

The longest wire rope in the world, has just been completed at the Patent Wire Rope Works of R. S. Newall & Co., Gateshead. It measures 6,000 yards in length, in *one piece,* without splice, and is longer, by 1000 yards, than any rope hitherto made. It is for the Durham and Sunderland Railway Company, who have at work, on *one engine,* 15,000 yards of Newall & Co's. wire rope; it is in *one*

length, but contains two splices. We understand that this particular kind of wire rope is now almost entirely used on the Blackwall Railway, and that in consequence there has not been a breakage during the last three months; whereas, formerly there were two or three breakages a day. Civ. Eng. & Arch. Journ.

Lunar Occultations.

Lunar Occultations visible in Philadelphia during the month of May, 1844; computed by Mrs. Charlotte S. Downes, from the Elements published with the Occultation list of the United States Almanac.

The Immersions and Emersions are for Philadelphia, mean astronomical time. Im. for Immersion, Em. for Emersion. These abbreviations in *Italics* refer to those Immersions and Emersions which take place on the Moon's dark limb. N. App. for Near Approach.

The angles are for *inverted image*, or as seen in an astronomical telescope, and reckoned from the Moon's North point and from its Vertex around through East, South, West, to North and Vertex again. For direct vision add 180°.

MAY, 1844.

Day.	H'r.	Min.	Star's name.	Mag.	From North.	From Vertex.
3	10	55	Im. *g* Ophiuchi,	5	148°	171°
	11	45	*Em.*		236	249
7	14	20	Im. τ^1 Capricorni,	6	51	93
	15	35	*Em.*		268	299
7	15	53	Im. τ^2 Capricorni,	6	59	80
	17	16	*Em.*		253	254
19	6	48	*Im.* Bessel,	9	47	352
	7	24	Em.		337	283
19	7	22	N. App. Bessel. ☽ N. 3′,	9		
20	7	59	*Im.* Bessel,	8.9	105	51
	8	58	Em.		287	264
20	8	37	*Im.* Bessel,	9	87	34
	9	29	Em.		304	255
20	9	6	*Im.* Bessel,	9	87	36
	9	56	Em.		304	257
20	9	48	*Im.* Bessel,	9	139	91
	10	29	Em.		249	204
20	9	40	*Im.* Bessel,	9	85	36
	10	34	Em.		302	258
21	6	46	*Im.* *f* Geminorum,	5.6	102	50
	7	54	Em		305	251
21	7	9	*Im.* Bessel,	9	159	106
	7	56	Em.		245	192
21	7	54	*Im.* Bessel,	9	130	76
	8	53	Em.		278	224
21	8	35	*Im.* Bessel,	9	86	32
	9	29	Em.		315	262
21	9	33	*Im.* Bessel,	9	71	19
	10	17	Em.		327	277
21	9	48	N. App. Bessel, ☽ S. 2′,	9		
21	9	44	*Im.* Bessel,	8	146	95
	10	28	Em.		251	201
22	6	12	*Im.* 29 Cancri,	6	146	106
	7	20	Em.		268	221
24	9	37	*Im.* 19 Sextantis,	7	138	92
	10	39	Em.		278	229
30	14	8	*Im.* δ Scorpii,	3	69	33
	15	9	Em.		301	261

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE

State of Pennsylvania

AND

AMERICAN REPERTORY.

MAY, 1844.

Civil Engineering.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Short methods of calculating correctly the Sectional Areas of Excavations, or Embankments. *By* Solomon W. Roberts, C. E.

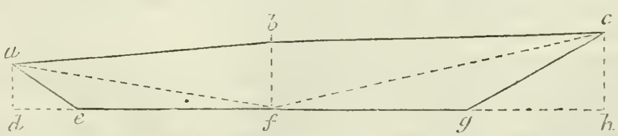
In the construction of most canals and railroads a large number of calculations are required of the sectional areas of excavations and embankments, many of which (called cross-sections of three cuttings) have the general form of the figure *a b c g e;* the depths of the cutting, or filling, being taken at the points *a*, *b*, and *c*. The point *b*, is in the centre line, and *a* and *c*, are the points where the side slopes strike the surface of the ground.

The three following methods, devised some years since, for accurately and readily obtaining such areas, are well adapted to facilitate the operation, and their correctness may be easily demonstrated:—

No. I.

Multiply the extreme width of the excavation, or embankment, measured horizontally, by one-half of the depth at the centre; multiply the sum of the depths at the sides, by one-fourth of the base line, or bottom width *(e g,)*—the sum of these products will be the sectional area required.

Thus, in the following diagram the centre stake standing at *b:*



$$\left(dh \times \frac{bf}{2}\right) + \left(\overline{ad + ch} \times \frac{eg}{4}\right) = \text{Sectional Area of } abcgfe.$$

The diagram in this position represents an excavation, by inverting it an embankment.

No. II.

The same result may be obtained with less calculation, by the use of a table, as follows, the cuttings being taken in feet and tenths, as usual:

Prepare a table of three columns, the first containing the depths at the centre, the second the sectional areas for each depth on level ground, the third the horizontal distance from the centre stake to the side slopes—such a table may be readily constructed. Then find the difference between the centre depth, and the average of the side depths, and multiply this difference into the number in the third column of the table opposite the centre cutting. If the average of the side depths is greater than the centre depth, add this product to the number in the second column, if less, subtract it, and the result will be the cross-section required.

No. III.

The following method, after making the table, is very convenient, on account of the substitution of addition and subtraction, for multiplication and division:

Prepare a table of twelve columns, the first containing the centre cuttings for feet and tenths, and the second the sectional area for each centre cutting, when the sum of the side cuttings is equal to that at the centre. The remaining columns, numbered from 1 to 10, are to be filled by inserting in the first, half the distance from each centre stake to the side slope, measured horizontally; in the second column twice the amount in the first; in the third three times the amount in the first; and so on.

To calculate a Sectional Area by this Table.

Subtract the centre cutting from the sum of the side cuttings—suppose this difference to be 4.70, for example—then from the column numbered 4, take out the amount opposite the given centre cutting; and for the seven-tenths take the amount in the 7th column, and move the decimal point one figure to the left; add these two amounts to the number in the column of areas, and *the sum will be the sectional area required.*

If the number of feet in the difference between the centre cutting, and the sum of the side cuttings exceeds ten, the amount for ten feet must be taken from the table, and be added to that for the remaining height taken from its corresponding column.

In those rare cases in which the sum of the side cuttings is less than the centre cutting, the amount caused by the difference must be deducted from that taken from the column of areas.

The demonstration of the foregoing rules depends upon simple trigonometrical principles, and it does not require to be elucidated here.

Philadelphia, April, 1844.

The Atmospheric Railway.

The vacuum pipe, which is the distinguishing characteristic of this railway, is about fifteen inches internal diameter; it is of cast-iron, united in the same manner as the gas, or water, pipes in our streets, and is laid in the centre between the two rails. A simple cutter is passed through the pipes when they come out of the foundry sand; and being raised to the temperature of melting tallow, a mop dipped in this material is passed through them, and being followed by a wooden piston, the inside becomes coated with a thin surface of tallow, which soon acquires considerable hardness; so that, practically, the traveling piston moves in a tube of tallow, and this method is found very effectual in preventing atmospheric leakage. On the top of the tube is a narrow opening, extending the whole length, which is closed with a valve for the purpose of rendering the tube air-tight when required. This valve is a continuous flap of leather, on the upper and under sides of which are riveted plates of iron, the inner surface of the lower plate being so shaped as to form, when the valve is closed, a portion of the circumference of the pipe; the upper plate and the leather being both a little wider than the opening, or "slot," and made to extend over it on each side. This continuous valve is hinged on one side to a projecting rib; and the other edge falls into a groove containing a mixture of wax and tallow, which, when melted, seals up the pipe, and makes it sufficiently air-tight for practical working. There is also a contrivance, called the weather-valve, for protecting the apparatus from the weather.

A reference to fig. 1, which is a cross section of the pipe when closed, will assist the reader in comprehending its structure.

Fig. 1.

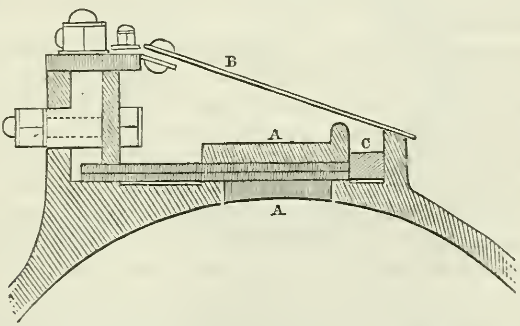
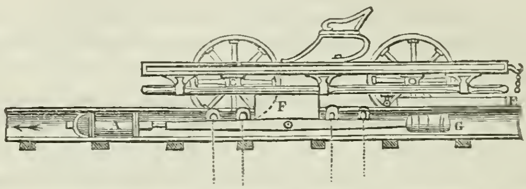


Fig. 1, is a transverse section of the upper part of the vacuum pipe when the valves are closed. A A, is the air-tight valve; B, the weather valve; and C, the composition of wax and tallow, or other suitable ingredients.

Within the pipe described is a piston, with a rod fourteen, or fifteen, feet in length, to which are attached rollers for opening the air-tight

valve at the rear of the piston, not in front, as it advances along the pipe. A "coulter" connects the piston to the driving car, as the first carriage is called; and to this car is connected a copper vessel several feet in length, heated with coke, for the purpose of melting the wax when the valve has been pressed down by the apparatus for that purpose, (see fig. 2.)

Fig. 2.



The reader is requested to bear in mind that the moving force depends upon the *difference* of pressure before and behind the piston. So long as these two forces are in equilibrium, they counterbalance each other; and there is no propulsive power. But disturb this equilibrium, destroy this balance of power, and we at once call into action an existing, but hitherto dormant, force, varying in amount with the extent to which the equilibrium has been destroyed. When, therefore, the vacuum pump has exhausted the air in front of the piston to the extent of 15 inches by the mercurial gauge, there is a pressure in front of half an atmosphere, say $7\frac{1}{2}$ lbs. to the square inch; but the pressure behind has not been disturbed; it is still a whole atmosphere, say 15 lbs. to the square inch; the propulsive force is consequently the difference between these, or $7\frac{1}{2}$ lbs. to the inch. If the exhaustion in front is carried to 25 inches, the remaining pressure is 5 inches; and the difference, 20 inches, indicates a propelling power of two-thirds of an atmosphere, or 10 lbs. on each square inch of the piston, being half a pound for each inch of exhaustion shown by the mercurial vacuum gauge.

Now the sectional area of a circular piston, 15 inches in diameter, is about 176 inches. When, therefore, a vacuum has been produced of 10 inches, or a third of an atmosphere, there is a power of 880 lbs.; a vacuum of 15 inches gives 1320 lbs.; and a vacuum of 20 inches, which is readily attained, gives 1760 lbs.; and it is considered that the average traction power of a locomotive is about 1000 lbs.

We may remark that as the area of a circle is in proportion to the square of the diameter, a pipe of $7\frac{1}{2}$ inches in width would have a force equal to one-fourth that of a pipe 15 inches wide; a pipe of 5 inches would be only one-ninth, and so in proportion.

We have assumed the weight of the atmosphere at 30 inches, as shown by the common barometer, and the pressure at 15 lbs. to the square inch. These amounts, though not strictly accurate, are sufficiently so for our purpose. On some very fine day, when the barometer stands at 30 inches, (all barometers are thus graduated,) should the piston be loaded to the full extent of its traction power, and the weather changing very suddenly, the barometer should fall to 28 inches, (which is a possible, though quite improbable, event,) the

power of the piston would be forthwith lessened one-fifteenth. The pressure in front continues the same, but the hind force, the weight of the atmosphere, as shown by the barometer, is two inches, or one-fifteenth, less than it was. We introduce this simply as an illustration of the principle of action, not as an event that will actually occur, though from time to time the variation in the weight of the atmospheric column, and, consequently, in the pressure on the piston, is greater than that we have named.

It will now be seen, that in the atmospheric railway, the traction power depends on the sectional area of the pipe, and the amount of vacuum, or rarefaction. The speed will be in proportion to the rapidity with which the air in front of the progressing piston can be drawn, or pumped, out of the tube. This exhaustion is easily carried to 23 or 24 inches, as shown by the mercurial gauge; (a perfect vacuum being 30) it is nearly simultaneous in the whole length of the pipe, and an exhaustion of 15 inches has been procured in less than two minutes. A speed has been attained of 50 or 60 miles an hour, and even 80, with a single carriage; and at this rapid rate the sealing apparatus performed its duties perfectly.

Fig. 3.

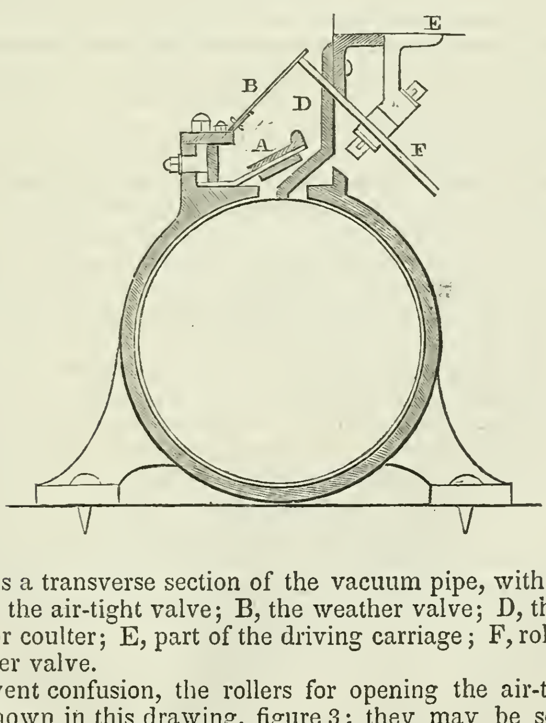


Fig. 3, is a transverse section of the vacuum pipe, with the valves open. A, the air-tight valve; B, the weather valve; D, the connecting arm, or coulter; E, part of the driving carriage; F, roller to open the weather valve.

To prevent confusion, the rollers for opening the air-tight valve are not shown in this drawing, figure 3; they may be seen in the longitudinal section, (figure 2,) in which the piston A, is seen traveling in the direction of the arrow. As it advances the two

small rollers B B, lift up the air-tight valve, which, when the coulter F, has passed, is allowed gradually to fall into the groove again, by the corresponding rollers C C, and is firmly pressed down into its right position by the upper roller D. The long heater E, follows, and melting the wax, (shown at C, in fig. 2,) re-seals the pipe; F, is the connecting arm, or coulter; and G, is the weight to counterbalance the piston. Between the carriage wheels is shown the seat for the conductor. (The roller for opening the weather valve will be seen in fig. 3.)

The pipe at the higher end is connected with a large air pump, worked by a stationary engine at Dalkey, for the purpose of exhausting, or, more correctly, partially exhausting, this pipe, and thereby causing, as we have before explained, a pressure at the opposite end. This pump is about $5\frac{1}{2}$ feet in diameter, or nearly twenty times the sectional area of the pipe; the length of the stroke is also about $5\frac{1}{2}$ feet, and when working it moves at the rate of 240 feet per minute. It is double acting.

Now the carriages being attached to the piston at Kingstown, and the air being pumped out of the tube, it is clear, that if the pressure is sufficiently great on the piston, the driving carriage must go forward. The train moves—the driving car, or piston carriage, opens the sealed valve—the apparatus for this purpose again presses the valve into its proper channel—the heater follows and seals it up—the engine continues to work the air-pump, to maintain the partial vacuum—the train arrives at its destination—and the pipe is ready sealed for a repetition of the same process.

The return voyage is to be performed without any power save that of gravitation. The carriages are to convey themselves down the line, and also the piston, which, not being needed in the descending journey, is placed outside, as horses are sometimes taught to mount a low truck when their power is not wanted. This contrivance also saves a needless working of the valves. On such an incline, (an average of 1 in 115, in some parts much steeper,) this will be easily effected, at a rate probably of 20 to 30 miles an hour. The writer of this article was, some time since, on a line of railway, which, though not designed for passengers, was in very good condition; and wishing to proceed four or five miles down an incline, much less steep than the Dalkey Railway, an empty wagon was attached to two loaded ones; they started, the motion was very easy, and as he stood on the wagon he found, very unexpectedly, that they had attained a speed of more than 30 miles an hour. Standing on an open truck, this was an unwarrantably dangerous rate, which he would not knowingly have attained.

To this description of the Atmospheric Railway we will add a few words relative to its history and progress.

The first suggestion of such a mode of transit is attributed to Papin, more than a century since. In recent times have followed Lewis, Vallance, Medhurst, Pinkus, and lastly, Clegg and Samuda. Professor Vignoles states, in 1842, that it was "Medhurst who, about thirty years since, first gave to the world the right idea of connecting the

body in the pipe, or tube, directly acted upon by the atmospheric power, with a carriage moving along exteriorly." He published several pamphlets on the subject, which did not attract much attention.

Mr. Vallance took out a patent, we believe, in 1824, and he constructed a pneumatic tunnel at Brighton, of about two hundred yards long, for experimental purposes, of sufficient capacity to contain a passenger carriage.

In 1834, Mr. Pinkus took out a patent, adopting the small tube suggested by Mr. Medhurst, and proposing to cover the aperture in the pipe with a rope. This plan, as we have stated, was not found sufficiently air-tight.

Lastly came Mr. Clegg, who, still adopting Medhurst's small tube, patented the beautifully simple apparatus which is the subject of this paper; and which is said to be quite calculated to endure the rough usage necessarily attendant on so rapid motion.

The half mile of experimental line erected on this principle, at the expense of the patentees, on the West London Railway, had been exhibited for many months without attracting much attention, when it was seen by James Pim, Jr., Esq., the Treasurer of the Dublin and Kingstown Railway, who at once warmly espoused the cause of the patentees, and addressed a letter to the President of the Board of Trade, urging the Railway department of that board to institute due inquiry into this new application of the atmospheric pressure. He says, "this claim is not made lightly, nor without a suitable feeling of responsibility; it has resulted from a careful and prolonged investigation, and from repeated experiments on the West London Railway, in which I have been assisted by many of the most distinguished men of science, and by several eminent practical engineers, whose concurrent opinions have led me to such a perfect conviction of the importance of the subject, as to induce this application."

He was successful; and the commissioners' report was so far satisfactory, that, as we have stated, Government consented to advance the money.

We should not omit to add, that the electric telegraph, by which signals can be transmitted with the speed of light itself, is to be a companion of the atmospheric railway.

Several distinguished foreigners have visited Kingstown; and M. Mallet, who was appointed by the French Government to visit the Dalkey line, has presented a report to the Minister of Public Works, recommending the government to construct a line of several miles in length, so as to require three or four stationary engines, for the purpose of testing the value of the invention, as he considers the future prospects of railways in France greatly concerned in the question.

London Sat. Mag.

Statistics of the Coal Trade.

The annual statement of the quantity of coals, culm, and cinders, imported into the port of London during the year 1843—specifying

the quantity of each description—has just been published, of which the following is a summary:—

	Ships.	Tons.
Newcastle coal,	1871	631,884
Ditto Wall's End,	1724	505,153
Sunderland coal	45	13,693
Ditto Wall's End,	2329	684,680
Stockton coal,	16	3,107
Ditto Wall's End,	1963	518,813
Scotch,	148	12,108
Yorkshire,	712	71,034
Small coal,	15	4,127
Welsh,	307	79,924
Blyth,	421	98,622
Sundry places,	2	190
Totals,	9553	2,623,335

Of culm there has been imported, in 9 ships, 1801 tons; and of cinders, in 31 ships, 3384 tons—making an aggregate total of 9593 ships, and 2,628,520 tons. These returns show a falling off, (as compared with 1841, in which was sold in the London market 2,909,144 tons—the largest quantity ever imported in one year,) of 270,624 tons; and, as the above quantity averages about 270 tons per cargo, it may be estimated that 1000 coal vessels, or about one-tenth, have been unemployed in that trade during 1843, which were so employed in the year 1841. In 1842, the quantity was intermediate — viz., 2,723,200 tons—showing a gradual decrease; and it would be an interesting inquiry to ascertain the cause of such diminution of consumption, with a two years' increase of population, probably 100,000, and how far it may be connected with the stagnant state of trade—the want of employment, and consequent distress of the people.

Lond. Mining Journ.

On the principal cause of the Rocking Motion of Locomotive Engines and Carriages. By G. Heaton.

Mr. G. Heaton's paper "On the principal cause of the rocking motion of Locomotive Engines and Carriages," was read January 31st, and several experiments, with machines made for the purpose, were shown by way of illustration.

Mr. Heaton's attention was first drawn to the subject early in the year 1838, when employed to examine a steam engine and machinery used for making boiler plates, rolled bars, &c. He found that the fly wheels of the engine, when revolving rapidly, made a very rumbling noise, and the lighter one would jump as high as the glad would let it; indeed, the whole building rocked when the machinery was in motion. It was found that the fly wheels were heavy sided, and that the smaller one, 16 feet in diameter, required 160 lbs. on one side, and the larger one, 18 feet in diameter, 322 lbs. to equipoise them. This having been done, the whole of the machinery moved easily

and quietly. This result caused the author to turn his attention to the rocking and jumping motion experienced in locomotive engines and carriages. The difference of speed at which the different parts of a wheel in motion progress, or the speed at which bodies descend through short distances, does not appear to have been taken sufficient notice of by engineers, as the heavy side of a wheel has to fall at certain intervals during its revolution sixty times as fast as it would fall by gravity alone. When a railway engine is traveling at the rate of 33 miles per hour, the top of its wheel is thrown forward at the rate of about 92 feet, and downward at the rate of 46 feet in a second. Railway carriage wheels are frequently 6 to 7 lbs. heavier on one side than on the other: it is no wonder, therefore, that the unpleasant motion experienced while traveling in carriages so circumstanced, is so often complained of. Without entering into detail with regard to the different machines used for the purpose of illustrating Mr. Heaton's views, it may be well to describe the most simple one, and the method of making the experiments. The model is made to represent the wheels and axle of a railway carriage, the axle being 16 inches long, and the wheels $6\frac{1}{4}$ inches diameter. By placing some loose pieces of iron inside the rims, so as to represent wheels which are $\frac{1}{6}$th of an inch thicker on one side than the other, the thick side of one wheel being placed opposite the thick side of the other, at the opposite ends of the axle, according to the common practice, and the wheels allowed to revolve, the model will continue to jump about the table, on which it is placed, so long as the wheels are in motion. Again, if the pieces of iron be all placed on the same side of the centre, the model will not rock as before, but jump up and down, and make more evolutions than in the last case. The wheels being perfectly equilibrated, will revolve without any oscillating movement, and the frame remain quite steady, the number of revolutions, with the same power, being considerably increased. The paper was accompanied by tables, showing the effects produced by the experiments made under different circumstances.

February 14.—Mr. Heaton continued his experiments illustrative of the principal cause of the rocking motion of railway engines and carriages. The machine by which these experiments were shown, consists of a cam ring, having four sets of cams on its periphery, viz., one set of sixteen cams, one set of eight cams, one set of four cams, and one set of two cams. When the cam ring is made to revolve, the cams raise a rod of iron 12 inches long, and supported at one end by a cross bar fixed between the centres; when the rod is fixed for the sixteen cams, it is raised three-fourth of an inch by each cam, and strikes (after the manner of a forge hammer) 292 blows per minute, or travels at the rate of $7\frac{1}{3}$ inches in a second, and no faster. When fixed for eight cams, to raise it $1\frac{1}{2}$ inch high, the rod strikes 224 blows per minute, or travels at the rate of $11\frac{1}{5}$ inches per second. When fixed for four cams, to raise it 3 inches high, the rod will strike 170 blows per minute, or travel at the rate of 17 inches per second—a half pound weight being fixed close to the end of the rod which is raised by the cam, two additional blows will be struck in one minute

more than when the rod is not thus loaded—and if the half pound weight be removed, and a two pound weight be fixed near to the centre of the rod, so as to require the same weight to raise it by each cam, it will strike 233 blows in a minute, or travel at the rate of 25⅓ inches in one second, showing that the one end of the rod working on the centres does not retard the falling of the rod lifted by each cam. Other experiments were made with the same machine with modifications, from which it appears that the small iron rod travels as fast as a forge hammer ordinarily used—that the velocity of a body falling short distances, is doubled when passing through double the distance—that allowance should be made for the momentum of the piston, piston-rod, and slide of a locomotive engine—and showing that a great loss of power is sustained by the wheels being heavy sided.—*Trans. Soc. Arts.*

Lond. Athenæum.

The Liverpool Screw.

A paper by Mr. J. Grantham, was read February 13th, describing a series of experiments on an iron vessel called the Liverpool Screw: This boat was 65 feet long, 12 feet 6 inches beam, and had 3 feet 9 inches draught of water. She was propelled by two high pressure oscillating engines, with cylinders 13 inches diameter, and 18 inches stroke. The pressure of the steam in the boiler varied from 50 lbs. to 60 lbs. per square inch; and it was cut off at one-fourth of the length of the stroke, working the remainder by expansion. The nominal power was 20 horses, but it did not really exceed 18½ horses. The cylinders were placed diagonally, with both the piston rods working upon the same crank; the driving shaft being beneath the cylinders, and running direct to the propeller, without the intervention of either gearing, or bands. The screw propeller was enlarged three times, and, at last, was left at 5 feet 4 inches diameter by 20 inches in length. It was set out with a pitch expanding from 10 to 11 feet, on Woodcroft's plan. It was made of wrought-iron, with four short arms with broad shovel ends, whose united area was 16 square feet, 13 feet only of it being immersed, as some portion of the arms was constantly above water. The angle of the centre of the float was 45°. The speed of the propeller was generally 95 revolutions per minute. With these dimensions, the speed attained was described as 10½ statute miles per hour. The amount of "slip" of the screw in the water, as ascertained by Massey's log, was stated not to exceed 5 per cent. Several experiments were detailed, which showed that there was not more tendency to "list," or to turn round, by the action of the screw, than with paddle wheels; and the vessel was said to have excelled all the other steamers of the port of Liverpool, in towing out vessels in a rough sea. Designs were submitted on this principle for a steam frigate, and for large steamers, working with oscillating cylinders direct upon the main shaft.

February 20.—The discussion on the "screw propeller" was re-

sumed. Mr. Grantham explained the construction of the propeller used on board the *Liverpool Screw.* It was formed of four arms with broad shovel ends, set at an angle of 45°, and, from his account, its action appeared to have been satisfactory; he also spoke highly of Ericsson's form of propeller, as better adapted, for large diameters, than any other kind. This statement was confirmed by Mr. Braithwaite, who promised, at a future meeting, to give the results obtained on board the *Princeton* steamer, United States, America.—*Trans. Inst. Civ. Eng.* Ibid.

The Thames Tunnel.

This great national undertaking having been completed, it stands forth a monument, not only of the science and perseverance of the engineer, Sir I. M. Brunel, but of the spirit and enterprize of the country. It may not be uninteresting to our readers to consider, in this place, the circumstances which gave rise to its formation, the difficulties which occurred in the course of its construction, and the expense incurred in working out the project. It would appear that the immense traffic carried on by various mercantile concerns below London Bridge, suggested to the minds of many intelligent engineers the desirability of constructing a communication from shore to shore, for the purpose of affording the necessary facilities to carry out the traffic in question with greater convenience to the parties engaged in it, particularly as regarded the saving of time, so important an ingredient in the commercial and mercantile affairs of this great metropolis. From the number and magnitude of the shipping constantly passing on the river, a bridge was out of the question, and the only plan that could be resorted to that would be free from objections on the ground of injury, or inconvenience, to the navigation of the Thames, was a tunnel under its bed. It seems that in 1799, a project was put forth for the formation of a tunnel at Gravesend, but the scheme was soon abandoned. In 1804, an attempt was made to construct a tunnel from Rotherhithe to Limehouse, and although a drift-way was carried under the river to the extent of 923 feet, and within 150 feet of the opposite shore, the work was abandoned, owing to difficulties that had occurred, and which the engineer declared at the time to be insurmountable. The plan of a tunnel under the river was, however, always looked upon as a matter of deep interest, and great importance, and when Sir I. M. Brunel, in 1824, exhibited his plan for constructing one with a double and capacious roadway, it was not only well received, but liberally supported by men of the first rank, both as regards station in society, and attainments in science. No one seems to have given it more cordial assistance than the Duke of Wellington, who was amongst the original subscribers to it. His Grace described it as "a work important in a commercial, as well as in a military and political point of view," and added, "that there was no work upon which the public interest of foreign nations had been more excited than upon this tunnel." The spot selected for the for-

mation of the work in question—namely, from Rotherhithe to Wapping—was considered to be the most desirable, not only as regarded the traffic in the immediate neighborhood of the tunnel, but also as related to the neighboring counties. An act of Parliament having been obtained on the 24th of June, 1824, and £180,000 having been raised by means of shares, Sir I. M. Brunel, the engineer, began his operations; but it was not until the 1st of January, 1826, that the shield by which the tunnel was to be worked was placed at the bottom of the shaft formed for its reception. The double archway of the tunnel was then proceeded with; but, on the 25th of the same month, the stratum of clay through which the work was being carried forward, broke off abruptly, and for six weeks the shield was left open to a considerable influx of land water. The consequence was that the progress of the work was much impeded. However, on the 11th of March following, the break in the clay having been passed, the work was proceeded with, and by the 30th of April, 1827, the tunnel had extended 400 feet under the river, and was fully and substantially completed with brick work. In the month of May, 1827, and again in January, 1828, the river broke in, and great apprehensions were entertained that this unprecedented undertaking must be abandoned. When, however, the chasms in the bed of the river had been filled up with bags of clay, and the water in the tunnel cleared out, it was found that the structure was in a perfectly sound and satisfactory state. These circumstances, however, and the entire expenditure of the capital of the company, prevented the work from being proceeded with until the year 1835, when a grant of public money was made by the treasury, through the Exchequer Loan Commissioners, to the company to complete the undertaking. The work was then proceeded with, and the result is the perfect completion of the tunnel, which is 1200 feet in length. The time occupied in the execution of the work was about nine years. The actual tunnel was completed in eight years. In addition to the £180,000 expended by the company, the treasury has advanced £270,000, making the total cost of the tunnel, up to the present moment, £450,000. The carriage way descents have yet to be formed, and it is estimated by Mr. Walker, that the cost of these descents will amount to £130,000, or £140,000, more. So that when the tunnel is perfect in all its parts, its total cost will be somewhere about £600,000. It appears that the returns from the tolls for foot passengers for the present year, are calculated at £15,000, and that the average for future years is estimated at £10,000, and this, with the tolls upon carriages, when the ways are formed, is considered likely to give not only to the proprietors a fair interest for their capital, but also to the Treasury for the sums advanced on the part of the public. How this may be, time will show, and with this brief notice of this truly unparalleled enterprize, we leave the matter in the hands of the public.

Mining Journal.

American Patents.

Information to persons having business to transact at the Patent Office.

Sec. 1. The existing laws relating to patents, are those approved July 4, 1836, March 3, 1837, March 3, 1839: all former acts having been repealed by the act of 1836.

Sec. 2. "Patents are granted for any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvement on any art, machine, manufacture, or composition of matter, not known, or used, by others before his, or their, discovery, or invention thereof, and not, at the time of his application for a patent, in public use, or on sale, with his, or their, consent, or allowance, as the inventor, or discoverer."—Act of 1836, section 6. "No patent shall be held to be valid by reason of the purchase, sale, or use, [of the invention] prior to the application for a patent, as aforesaid, except on proof of abandonment of such invention to the public, or that such purchase, sale, or public use, has been for more than two years prior to such application for a patent."—Act of March 3, 1839.

Sec. 3. The term for which a patent is granted is fourteen years; but it may, under certain circumstances, be renewed for seven years, as hereinafter mentioned.

Sec. 4. Patents are granted to citizens of the United States, to aliens who shall have been resident in the United States one year next preceding, and shall have made oath of their intention to become citizens thereof, and also to foreigners who are inventors, or discoverers.

Sec. 5. A patent may be taken out by the inventor in a foreign country, without affecting his right to a patent in the United States, provided the invention has not been introduced into public and common use in the United States prior to the application for such patent. In every such case the patent is limited to fourteen years, from the date of the foreign letters patent. A patent is not granted upon introduction of a new invention from a foreign country, unless the person who introduced it be the inventor, or discoverer. If an alien neglects to put, and continue on sale, the invention in the United States, to the public, on reasonable terms, for eighteen months, the patentee loses all benefit of the patent.

Sec. 6. Joint inventors are entitled to a joint patent, but neither can claim one separately.

Sec. 7. An inventor can assign his right before a patent is obtained, so as to enable the assignee to take out a patent in his own name; but the assignment must be first entered of record; and the application, therefore, must be duly made, and the specification signed, and sworn to by the inventor. And in the case of an assignment by a foreigner, the same fee will be required as if the patent issued to the inventor.

Sec. 8. The assignment of a patent may be to the whole, or to an

undivided part, "by any instrument in writing." All assignments, and also the grant, or conveyance, of the use of the patent in any town, county, state, or specified district, must be recorded in the Patent Office within three months from the date of the same. But assignments, if recorded after the three months have expired, will be on record as notice to protect against subsequent purchases. No fee is now charged for recording assignments. Patents, grants, and assignments recorded prior to the 15th of December, 1836, must be recorded anew before they can be valid as evidence of any title. This is also done free of expense.

Sec. 9. In case of the decease of an inventor, before he has obtained a patent for his invention, "the right of applying for and obtaining such patent shall devolve on the administrator, or executor, of such person, in trust for the heirs-at-law of the deceased, if he shall have died intestate; but if otherwise, then in trust for his devisees, in as full and ample manner, and under the same conditions, limitations, and restrictions, as the same was held, or might have been claimed, or enjoyed, by such person in his, or her, lifetime; and when application for a patent shall be made by such legal representatives, the oath, or affirmation, shall be so varied as to be applicable to them." Act of 1836, section 10.

Sec. 10. The Patent Office will be open for examination during office hours, and applicants can personally, or by attorney, satisfy themselves, on inspection of models and specifications, of the expediency of filing an application for a patent.

Sec. 11. All fees received are paid into the treasury, and the law has required the payment of the patent fee before the application is considered; two-thirds of which fee is refunded on withdrawing the application. But no money is refunded on the withdrawal of an application, after an appeal has been taken from the decision of the Commissioner of Patents. And no part of the fee paid for caveats, and on applications for the addition of improvements, reissues, and appeals, can be withdrawn.

Sec. 12. It is a frequent practice for inventors to send a description of their inventions to the office, and inquire whether there exists any thing like it, and whether a patent can be had therefore. *As the law does not provide for the examination of descriptions of new inventions, except upon application for a patent, no answers can be given to such inquiries.*

On the Application for a Patent.

Sec. 13. No application can be examined until the fee for the patent is paid, and the specification, model, and drawings filed.

Sec. 14. The application for a patent must be made by petition to the *Commissioner of Patents*, signifying a desire of obtaining an exclusive property in the invention, or discovery, and praying that a patent may be granted therefor, as in the form annexed hereto; *which petition should be signed by the inventor.*

Description, or Specification.

Sec. 15. Before any inventor shall receive a patent for any such

new invention, or discovery, he shall deliver a written description of his invention, or discovery, and of the manner and process of making, constructing, using, and compounding the same in such full, clear, and exact terms, avoiding unnecessary prolixity, as to enable any person skilled in the act, or science, to which it appertains, or with which it is most nearly connected, to make, construct, compound, and use the same, and in case of any machine, he shall fully explain the principle, and the several modes in which he has contemplated the application of that principle, or character, by which it may be distinguished from other inventions; he shall particularly specify and point out the part, improvement, or combination, which he claims as his own invention, or discovery."—Act of 1836, sec. 6. [See form annexed.]

Sec. 16. It is important, in all cases, to have the specification describe the sections of the drawings, and refer by letters to the parts; duplicate drawings being required.

Sec. 17. A *defective* specification, or drawing, may be amended at any time before a patent has issued; in which case the applicant will be required to make oath anew.

On New Improvements.

Sec. 18. "Whenever the original patentee shall be desirous of adding the description and specification of any new improvement of the original invention, or discovery, which shall have been invented, or discovered, by him subsequent to the date of his patent, he may, like proceedings being had in all respects as in the case of original applications, and on the payment of fifteen dollars, as hereinafter mentioned, have the same annexed to the original description and specification; and the Commissioner shall certify, on the margin of such annexed description and specification, the time of its being annexed and recorded; and the same shall thereafter have the same effect in law, to all intents and purposes, as though it had been embraced in the original description and specification."—Act of 1836, section 13.

Sec. 19. In all such cases the claim in the original patent is subject to a re-examination; and if it shall appear that any part of the claim was not original at the time of granting the patent, a disclaimer of said part must be filed in the Patent Office, or the specification of claims restricted, by having the patent reissued, before the improvement can be added. And if there is not anything which can be claimed, the improvement can not be added, but may be secured by a separate patent, on the payment of the fee of thirty dollars. If the patent was granted before the 15th of December, 1836, a model and drawings of the invention, as first patented, verified by oath, must be furnished, unless dispensed with by the Commissioner.

Sec. 20. No patent for an improvement can be granted to the original inventor, assignee, or possessor, of a patent granted before the 15th of December, 1836, until a model and drawings of the invention, as originally patented, verified by oath, shall have been deposited, unless dispensed with by the Commissioner.

Sec. 21. "Every inventor, before he can receive a patent, must

make oath, or affirmation, that he does verily believe that he is the original and first inventor, or discoverer, of the art, machine, manufacture, composition, or improvement, for which he solicits a patent; and that he does not know, or believe, that the same was ever before known, or used; and also of what country he is a citizen."—Act of 1836, sec. 6. [See form annexed.] In every case the oath, or affidavit, must be made before a person having general powers to administer oaths. Justices of the Peace have not, in all cases, this general power.

Sec. 22. If the applicant be an alien, and have resided one year in the United States next preceding the application, and have given legal notice of his intention to become a citizen of the United States, he must make oath to these facts before he can apply for a patent for the same fee as that paid by a citizen.

Of Drawings.

Sec. 23. The law requires that "the applicant for a patent shall accompany his application with drawings, and written references, *when the nature of the case admits of drawings.*" These drawings should, in general, be in perspective, and neatly executed; and such parts as can not be shown in perspective, must, if described, be represented in section, or detail. Duplicates of them are required, as one must accompany the patent when issued, as explanatory of it, and one must be kept on file in the office.

Sec. 24. The drawings must be signed by the patentee, and attested by two witnesses, except when the specification describes the sections, or figures, and refers to the parts by letters; in which case they are neither required to be signed, nor accompanied by written references upon the drawings, the whole making one instrument. Drawings are absolutely necessary, when the case admits of them.

Sec. 25. An examination, as to originality of invention, may be made on a single drawing; but duplicates will be required before the patent issues.

Of Models, and Specimens of Ingredients.

Sec. 26. The law requires that the inventor shall deliver a model of his invention, or improvement, when the same admits of a model. The model should be neatly made, and as small as a distinct representation of the machine, or improvement, and its characteristic properties will admit; the name of the inventor should be printed, or engraved upon, or affixed to it in a durable manner. Models forwarded without a name, cannot be entered on record, and are, therefore, liable to be lost, or mislaid.

Sec. 27. When the invention is of "a composition of matter," the law requires that the application be accompanied with specimens of the ingredients, and of the composition of matter, sufficient in quantity for the purpose of experiment.

On Granting Anew Lost Patents.

Sec. 28. The third section of the act of Mach 3, 1837, provides: "Sec. 3. *And be it further enacted,* That whenever it shall appear

to the Commissioner that any patent was destroyed by the burning of the Patent Office building on the aforesaid fifteenth day of December, or was otherwise lost prior thereto, it shall be his duty, on application therefor by the patentee, or other person interested therein, to issue a new patent for the same invention, or discovery, bearing the date of the original patent, with his certificate thereon, that it was made and issued pursuant to the provisions of the third section of this act, and shall enter the same of record: *Provided, however,* That before such patent shall be issued, the applicant therefor shall deposit in the Patent Office a duplicate, as near as may be, of the original model, drawings, and description, with specification of the invention, or discovery, verified by oath, as shall be required by the Commissioner; and such patent, and copies of such drawings and descriptions, duly certified, shall be admissible as evidence in any judicial court of the United States, and shall protect the rights of the patentee, his administrators, heirs, and assigns, to the extent only in which they would have been protected by the original patent and specification."

Proceedings on Application for Patents, and on Appeals from Decision of the Commissioner. (Act of 1836, sec. 7.)

Sec. 29. "That on the filing of any such application, (consisting of petition, specification, model, and drawings, or specimens,) and the payment of the duty hereinafter provided, the Commissioner shall make, or cause to be made, an examination of the alleged new invention, or discovery; and if, on such examination, it shall not appear to the Commissioner that the same had been invented, or discovered, by any other person in this country prior to the alleged invention, or discovery, thereof by the applicant, or that it had been patented, or described, in any printed publication in this, or any foreign, country, or had been in public use, or on sale, with the applicant's consent, or allowance, prior to the application, if the Commissioner shall deem it to be sufficiently useful and important, it shall be his duty to issue a patent therefor; but whenever, on such examination, it shall appear to the Commissioner that the applicant was not the original and first inventor, or discoverer, thereof, or that any part of that which is claimed as new had before been invented, or discovered, or patented, or described in any printed publication in this, or any foreign, country, as aforesaid, or that the description is defective and insufficient, he shall notify the applicant thereof, giving him briefly such information and references as may be useful in judging the propriety of renewing his application, or of altering his specification to embrace only that part of the invention, or discovery, which is new. In every such case, if the applicant shall elect to withdraw his application, relinquishing his claim to the model, he shall be entitled to receive back twenty dollars, part of the duty required by this act, on filing a notice in writing of such election in the Patent Office; a copy of which, certified by the Commissioner, shall be a sufficient warrant to the Treasurer for paying back to the said applicant the said sum of twenty dollars. But if the applicant, in such case, shall persist in his claim for a patent, with, or without, any alteration of his specification, he

shall be required to make oath, or affirmation, anew, in manner as aforesaid; and if the specification and claim shall not have been so modified, as, in the opinion of the Commissioner, shall entitle the applicant to a patent, he may appeal to the Chief Justice of the United States Court for the District of Columbia, who may affirm, or reverse, the decision of the Commissioner of Patents in whole, or in part, and may order a patent to issue; or he may have remedy against the decision of the Commissioner of Patents, or the decision of the Chief Justice of the United States Court for the District of Columbia, by filing a bill in equity in any of the United States Courts having jurisdiction, as hereinafter explained.

Reissue to Correct a Defective Description.

Sec. 30. When an applicant wishes to cancel an old patent, and to correct a mistake, or error, which has arisen from inadvertence, he should state this fact in his application, and expressly *surrender* the old patent, which must be transmitted to the Patent Office before a new patent will be issued. And no improvement, or alteration, made subsequent to the filing of the application upon which the original patent was granted, can be introduced into a patent upon reissue. Section thirteen of the act of July, 1836, enacts, "That whenever any patent, which has heretofore been granted, or which shall hereafter be granted, shall be inoperative, or invalid, by reason of a defective, or insufficient description, or specification, or by reason of the patentee claiming in his specification, as his own invention, more than he had, or shall have a right to claim as new, if the error has, or shall have, arisen by inadvertency, accident, or mistake, and without any fraudulent, or deceptive, intention, it shall be lawful for the Commissioner, upon the surrender to him of such patent, and the payment of the further duty of fifteen dollars, to cause a new patent to be issued to the said inventor for the same invention for the residue of the period then unexpired, for which the original patent was granted, in accordance with the patentee's corrected description and specification.

Sec. 31. When the original patent has been lost, before a reissue can be granted, the original patent should first be restored, (as explained in section 28 of this circular,) and then surrendered.

Sec. 32. In the reissue, the claim is subject to an examination, as in the case of original patents; and if it shall appear that any part of the claim was not original at the time of granting the patent, the reissue will not be granted, unless said part be omitted in the claim, or a disclaimer filed in the Patent Office. And if there is not anything which can be claimed, the reissue cannot be granted, and the surrendered patent cannot be returned. Where the patent was granted before the 15th of December, 1836, a model and drawings of the invention as originally patented, verified by oath, must be deposited in the Patent Office before a reissue can be granted, unless dispensed with by the Commissioner.

Sec. 33. And in case of the death of an inventor, or of any assignment of the original patent, made by him, a similar right vests in his executors, administrators, or assignees; and the patent so reissued,

together with the corrected description and specification, have the same effect and operation in law, on the trial of all actions thereafter commenced for causes subsequently accruing, as though the same had been originally filed in such corrected form before the issuing out of the original patent.

Sec. 34. On the surrender of a patent, several patents may be issued for distinct and separate parts of the invention, upon the payment of thirty dollars for every additional patent issued.

Disclaimers.

Sec. 35. The 7th section of the law of 3rd March, 1837, provides, as follows:—

"Sec. 7. *And be it further enacted,* That whenever any patentee shall have, through inadvertence, accident, or mistake, made his specification of claim too broad, claiming more than that of which he was the original, or first, inventor, some material and substantial part of the thing patented being truly and justly his own, any such patentee, his administrators, executors, and assigns, whether of the whole, or of a sectional, interest therein, may make disclaimer of such parts of the thing patented as the disclaimant shall not claim to hold by virtue of the patent, or assignment, stating therein the extent of his interest in such patent; which disclaimer shall be in writing, attested by one, or more, witnesses, and recorded in the Patent Office, on payment by the person disclaiming, in manner as other patent duties are required by law to be paid, of the sum of ten dollars. And such disclaimer shall thereafter be taken and considered as part of the original specification, to the extent of the interest which shall be possessed in the patent, or right, secured thereby, by the disclaimant, and by those claiming by, or under, him, subsequent to the record thereof. But no such disclaimer shall affect any action pending at the time of its being filed, except so far as it may relate to the question of unreasonable neglect, or delay, in filing the same."

Sec. 36. In cases of patents granted before the 15th of December, 1836, no disclaimer will be admitted for record until a model and drawings of the invention, as originally patented, verified by oath, shall have been deposited, unless dispensed with by the Commissioner.

Interfering Applications.

Sec. 37. "Whenever an application shall be made for a patent, which, in the opinion of the Commissioner, would interfere with any other patent for which an application may be pending, or with any unexpired patent which shall have been granted, it shall be the duty of the Commissioner to give notice thereof to such applicants, or patentees, as the case may be; and if either shall be dissatisfied with the decision of the Commissioner, on the question of priority of right, or invention, on a hearing thereof he may appeal from such decision, on the like terms and conditions as are provided in the case of applications for inventions not new; and the like proceedings shall be had to determine which, or whether either, of the applicants is entitled to receive a patent as prayed for."—Act of 1836, section 8.

Caveats.

Sec. 38. The law enacts, "That any citizen of the United States, or alien, who shall have been a resident of the United States one year next preceding, and shall have made oath of his intention to become a citizen thereof, who shall have invented any new art, machine, or improvement thereof, and shall desire further time to mature the same. may, on paying to the credit of the Treasury, in manner as provided in the ninth section of this act, the sum of twenty dollars, file in the Patent Office a caveat setting forth the design and purpose thereof, and its principal and distinguishing characteristics, and praying protection of his right, till he shall have matured his invention; which sum of twenty dollars, in case the person filing such caveat shall afterwards take out a patent for the invention therein mentioned, shall be considered a part of the sum herein required for the same. And such caveat shall be filed in the confidential archives of the office, and preserved in secrecy. And if application shall be made by any other person, within one year from the time of filing such caveat, for a patent of any invention with which it may, in any respect, interfere, it shall be the duty of the Commissioner to deposit the description, specifications, drawings, and model, in the confidential archives of the office, and to give notice (by mail) to the person filing the caveat of such application, who shall within three months after receiving the notice, if he would avail himself of the benefit of his caveat, file his description, specifications, drawings, and model; and if, in the opinion of the Commissioner, the specifications of claim interfere with each other, like proceedings may be had in all respects as are in this act provided in the case of interfering applications."—Act of 1836, section 12.

Extension of a Patent beyond the Fourteen Years.

Sec. 39. Section eighteen enacts, "That whenever any patentee of an invention, or discovery, shall desire an extension of his patent beyond the term of its limitation, he may make application therefor, in writing, to the Commissioner of the Patent Office, setting forth the grounds therefor; and the Commissioner shall, on the applicant's paying the sum of forty dollars to the credit of the Treasury, as in the case of an original application for a patent, cause to be published in one, or more, of the principal newspapers in the city of Washington, and in such other paper, or papers, as he may deem proper, published in the section of country most interested adversely to the extension of the patent, a notice of such application, and of the time and place when and where the same will be considered, that any person may appear and show cause why the extension should not be granted. And the Secretary of State, Commissioner of the Patent Office, and the Solicitor of the Treasury, shall constitute a board to hear and decide upon the evidence produced before them, both for and against the extension, and shall sit for that purpose at the time and place designated in the published notice thereof. The patentee shall furnish to said board a statement, in writing, under oath, of the ascertained value of the invention, and of his receipts and expenditures,

sufficiently in detail to exhibit a true and faithful account of loss and profit in any manner accruing to him from, and by reason of, said invention. And if, upon a hearing of the matter, it shall appear to the full and entire satisfaction of said board, having due regard to the public interest therein, that it is just and proper that the term of a patent should be extended, by reason of the patentee, without neglect, or fault, on his part having failed to obtain, from the use and sale of his invention, a reasonable remuneration for the time, ingenuity, and expense bestowed upon the same, and the introduction thereof into use; it shall be the duty of the Commissioner to renew and extend the patent, by making a certificate thereon of such extension, for the term of seven years from and after the expiration of the first term; which certificate of said board of their judgment and opinion as aforesaid, shall be entered on record in the Patent Office; and thereupon the said patent shall have the same effect in law as though it had been originally granted for the term of twenty-one years; and the benefit of such renewal shall extend to assignees and grantees of the right to use the thing patented, to the extent of their respective interests therein: *Provided, however*, that no extension of a patent shall be granted after the expiration of the term for which it was originally issued.

Fees Payable at the Patent Office.

Sec. 40. All fees must be paid in advance; the amount fixed by law, except in the case of drawings, the expense of which will be communicated on application for the same.

Sec. 41. Every applicant must pay into the Treasury of the United States, or into the Patent Office, or into any other of the deposit banks, a deposit to the credit of the Treasurer, on presenting his petition, or application, as follows:

Sec. 42. If a citizen of the United States, as a patent fee,	$30.00
Sec. 43. If a foreigner, who has resided in the United States one year next preceding the application for a patent, and shall have made oath of his intention to become a citizen,	30.00
Sec. 44. If a subject of the Sovereign of Great Britain,	500.00
Sec. 45. All other foreigners,	300.00
Sec. 46. On entering a caveat,	20.00
Sec. 47. On entering an application for an appeal from the decision of the Commissioner,	25.00
Sec. 48. On extending a patent beyond the fourteen years,	40.00
Sec. 49. For adding to a patent the specification of a subsequent improvement,	15.00
In case of reissues, for every additional patent,	30.00
Sec. 50. On surrender of an old patent, to be reissued, to correct a mistake of the patentee,	15.00
Sec. 51. For a disclaimer,	10.00
Sec. 52. For copies of patents, or any other paper on file, for each 100 words,	.10

Sec. 53. For copies of drawings, a reasonable sum, in proportion to the time occupied in making the same.

Sec. 54. Communications to and from the Patent Office, are free of postage.

Sec. 55. All fees under five dollars, if sent to the Commissioner of Patents, should be transmitted in specie.

Sec. 56. It is recommended to make a deposit in a specie paying deposit bank, of the fee for a patent, or other application, and to remit the certificate. Where this can not be done without much inconvenience, gold may be remitted by mail free of postage.

Sec. 57. In case of deposits made in the deposit banks, a duplicate receipt should be taken, stating by whom the payment is made, and for what object. The particular invention should be referred to, to enable the applicant to recover back the twenty dollars, in case of the withdrawal of the petition. The certificate of deposit may be in the following form:

Sec. 58. *Bank of*

The Treasurer of the United States has credit at this office for dollars in specie, deposited by , of the town of , in the county of , and State of , the same being for a patent [or whatever the object may be] for a steam boiler.

Sec. 59. N. B. The Patent Office does not make original drawings to accompany applications for patents, and furnishes copies of the same only after the patent is completed. Draughtsmen in the city of Washington are always ready to make drawings, at the expense of the patentees.

On Recovering back Money paid for a Patent not taken out.

Sec. 60. When an applicant, who is a citizen, or a resident alien, relinquishes, or abandons, the application for a patent, he must petition the Commissioner of Patents, stating the abandonment, or withdrawal, of his application; in which case twenty dollars will be repaid. If this withdrawal be of a foreign patent, two-thirds of the fee paid is to be returned.

Sec. 61. In case of withdrawing a petition, the model deposited is by law retained.

Sec. 62. Whenever a patent is refused by the Commissioner on the ground that the alleged invention is not new, or interferes with an existing patent, or is not sufficiently useful and important, or in case of two, or more, interfering applications, the party, or parties, against whom the Commissioner has decided, can have remedy by an "appeal to the Chief Justice of the District Court of the United States for the District of Columbia, by giving notice thereof to the Commissioner, and filing in the Patent Office, within such time as the Commissioner shall appoint, his reasons of appeal specifically set forth in writing, and also paying into the Patent Office, to the credit of the patent fund, the sum of twenty-five dollars. And it shall be the duty of said Chief Justice, on petition, to hear and determine all such appeals, and to revise such decisions in a summary way, on the evidence produced before the Commissioner, at such early and convenient time as he may appoint, first notifying the Commissioner of the time and place

of hearing, whose duty it shall be to give notice thereof to all parties who appear to be interested therein, in such manner as said Judge shall prescribe. The Commissioner shall also lay before the said Judge all the original papers and evidence in the case, together with the grounds of his decision, fully set forth in writing, touching all the points involved by the reasons of appeal, to which the revision shall be confined. At the request of any party interested, or at the desire of the Judge, the Commissioner, and the Examiners in the Patent Office, may be examined, under oath, in explanation of the principles of the machine, or other thing for which a patent, in such case, is prayed for. And it shall be the duty of said Judge, after a hearing of any such case, to return all the papers to the Commissioner, with a certificate of his proceedings and decision, which shall be entered of record in the Patent Office; and such decision, so certified, shall govern the further proceedings of the Commissioner in such case: *Provided, however,* That no opinion, or decision, of the Judge, in any such case, shall preclude any person interested in favor, or against the validity, of any patent which has been, or may hereafter be, granted, from the right to contest the same in any judicial court, in any action in which its validity may come in question."

Remedy in Equity for Patentees.

Sec. 63. In cases where patents are refused for any reasons whatever, or when there shall be two interfering patents, remedy can be had from the decisions of the Commissioner of Patents, or from the Chief Justice of the United States Court for the District of Columbia, by bill in equity; and the Court having cognizance thereof, on notice to adverse parties (and when there shall be no adverse party, a copy of the bill shall be served upon the Commissioner of Patents, when the whole of the expenses of the proceedings shall be paid by the applicant, whether the final decision shall be in his favor, or otherwise,) and other due proceedings had, may adjudge and declare either the patents void in the whole, or in part, or inoperative, and invalid, in any particular part, or portion, of the United States, according to the interest which the parties to such suit may possess in the patent, or the inventions patented, and may also adjudge that such applicant is entitled, according to the principles and provisions of this act, to have and receive a patent for his invention, as specified in his claim, or for any part thereof, as the fact of priority of right, or invention, shall, in any such case, be made to appear. And such adjudication, if it be in favor of the right of such applicant, shall authorize the Commissioner to issue such patent, on his filing a copy of the adjudication, and otherwise complying with the requisitions of this act: *Provided, however,* That no such judgment, or adjudication, shall affect the rights of any person, except the parties to the action, and those deriving title from, or under, them subsequent to the rendition of such judgment.

On Filing the Specification and Drawings as a Caveat.

Sec. 64. "Whenever the applicant shall request it, the patent shall

take date from the time of filing the specification and drawings, not, however, exceeding six months prior to the actual issuing of the patent; and, on like request, and the payment of the duty herein required, by any applicant, his specification and drawings shall be filed in the secret archives of the office, until he shall furnish the model, and the patent be issued, not exceeding the term of one year; the applicant being entitled to notice of interfering applications."—Act of 1836, section 8.

Sec. 65. A full description of the invention is required, to enable the Commissioner of Patents to judge of interferences.

Sec. 66. All applications will be examined, and patents issued, in the order of time in which the proper documents are completed.

(To be Continued.)

Mechanics, Physics, and Chemistry.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Mode of Coloring Daguerréotype Pictures. By Charles G. Page, M. D., *Prof. Chem., Columbia College, Washington, D. C.*

In the month of December, 1842, I instituted a course of experiments to determine the effects of oxidation upon the surface of Daguerréotype pictures, and arrived at some beautiful results in fixing, strengthening, and coloring these impressions. Numerous and arduous duties of a public nature have prevented me from investigating the subject as I wished, and I, therefore, present the facts for others to adopt as the basis of what promises to be a most interesting course of study and experiment.

First, a mode of fixing and strengthening pictures by oxidation:—

The impression being obtained upon a highly polished plate, and made to receive, by galvanic agency, a very slight deposit of copper from the lupreous cyanide of potassa, (the deposit of copper being just enough to change the color of the plate in the slightest degree,) is washed very carefully with distilled water, and then heated over a spirit lamp until the light parts assume a pearly transparent appearance. The whitening and cleaning up of the picture, by this process, is far more beautiful than by the ordinary method of fixation by a deposit of gold. A small portrait fixed in this way, more than a year since, remains unchanged, and continues to be the admiration of persons interested in this art. One remarkable effect produced by this mode of fixing, is the great hardening of the surface, so that the impression is effaced with great difficulty. I have kept a small portrait thus treated, unsealed and uncovered for over a year, and have frequently exposed it in various ways, and rubbed it smartly with a tuft of cotton, without apparently injuring it; in fact, the oxidized surface is as little liable to change as the surface of gold, and is much harder. As copper assumes various colors, according to the depth of oxidation upon its surface, it follows that if a thicker coating than the first

mentioned, can be put upon the plate without impairing the impression, various colors may be obtained during the fixation. It is impossible for me to give any definite rules concerning this last process, but I will state, in a general way, that my best results were obtained by giving the plate such a coating of copper as to change the tone of the picture, that is, give it a coppery color, and then heating it over a spirit lamp until it assumes the color desired. I have now an exposed picture treated in this way at the same time with the two above mentioned, and it remains unchanged. It is of a beautiful green color, and the impression has not suffered in the least by the oxidation. Should this process be perfected, so as to render it generally available, it will be greatly superior to the present inartistical mode of stippling dry colors upon the impression; for the color here is due to the surface of the picture itself. For pure landscapes, it has a pleasing effect, and by adopting some of the recent inventions for stopping out the deposit of copper, the green color may be had whereever desired. In some pictures a curious variety of colors is obtained, owing to the varying thickness of the deposit of copper, which is governed by the thickness of the deposit of mercury forming the picture. In one instance a clear and beautiful ruby color was produced, limited in a well defined manner to the drapery, while all other parts were green. To succeed well in the first process, viz., that for fixation and the production of the pearly appearance, the impression should be carried as far as possible without solarization, the solution of the hyposulphite of soda should be pure and free from the traces of sulphur,* the plate should be carefully washed with distilled water, both before and after it receives the deposit of copper, in fact, the whole experiment should be neatly performed, to prevent what the French significantly call *taches* upon the plate, when the copper comes to be oxidized.

Description of an Improved Loom for Weaving Horse-Hair. By Mr. Henry Potts.

The object of Mr. Potts' improvement on the ordinary horse hair loom is to enable the weaver to dispense with the attendance of a server, whose business it is to place the ends of the horse hair in the hook, which draws them into the shed, where they are secured by the weaver striking up the batten with his left hand.

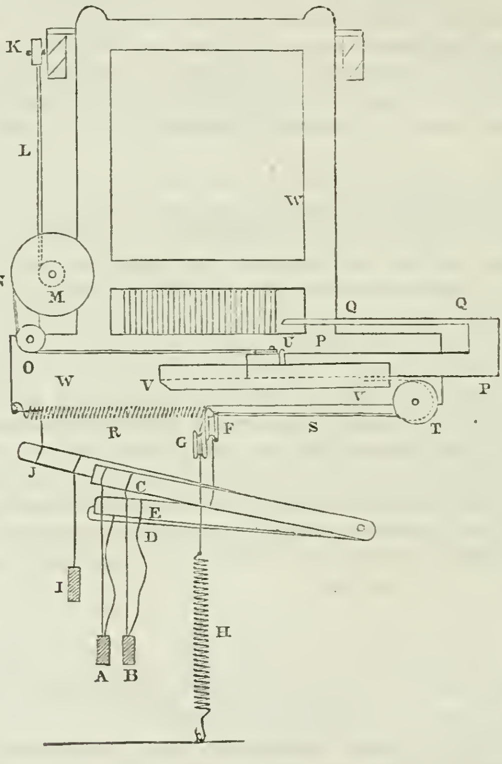
The parts of Mr. Potts' improved loom are so arranged, that the batten may be worked by the harness treadles, while an extra treadle is added for the purpose of passing the hook into the opening.

* The presence and deposit of sulphur, is a fault of most of the hyposulphite of soda of commerce, and it is the action of this sulphur upon the silver, that puzzles so many Daguerreotypers, by clouding, staining, and marking the plates in various ways. It may be obviated by repeatedly filtering the solution, or by keeping it in lightly corked bottles a long time before it is used.

In addition to the above I may state that exposure, of the coppered picture, to the vapor of hydrosulphuret of ammonia, produces sometimes a pleasing effect, but usually spoils the impression.

It is necessary that the weaver should have the use of both hands, for the purpose of taking up each shoot, doubling it, and laying it in the hook, the short end being held by the hand, while the hook carries, or guides, the other end to the opposite side of the opening, and finally leaves it lying straight across the threads of the warp.

In the accompanying view the framing which supports the several parts of the machine is purposely omitted.



The harness treadles, A and B, are attached by cords of equal length to a common lever C, and by the slack strings, as shown in the cut, to two other levers D and E, which, being tied to the lams, open the shed; while the lever C, draws back the batten by a cord passing over the pulley F, to the back of the batten; and, from the same point of fastening, another cord passes over the pulley G, in front of the batten to the helical spring H, which is attached to the floor, the object of which spring is to pull the batten forward; thus, when either of the treadles, A, or B, is down, the shed is open, and the batten held back; the treadle I, being then depressed, draws down the fourth cross lever J, which is connected by a cord with an equal lever K, pulling its back end down, while its front end rises with the string L, pulling round the small pulley M, which is fixed to the hinder part of the larger pulley N, to increase the motion, a cord

from which passes by the pulley to the near end of the slide P, and pulls it across the batten. The slide P, conveys the hook Q, at sufficient height to enter the shed, so as to pass through it, when the hair, being laid on to the hook, the treadle I, is released. The hook then flies back, its slide P, being drawn laterally by the spring R, and string S, which, after passing partly round the pulley T, is fixed to the under part of the slide. The slide moves freely in a trough V V, under the staple U, the object of which staple is to keep it in its place on the batten W W.

The hook Q Q, as shown in the cut, moves as much more than the treadle I, as the pulley N, is larger than the pulley M.

Trans. Soc. Arts, &c.

Description of an Improved method of Casting Screws. By Mr. William Bowser.

The difficulty of casting square threaded screws by the ordinary method, is owing to the nature of the spiral curve of the thread, which, presenting its angle of inclination parallel with the axis in opposite directions on each side thereof, prevents the possibility of removing the pattern without displacing some of the sand. To remedy this defect, Mr. W. Bowser has contrived a plan by which the patterns of square threaded screws may be withdrawn from the sand, and still leave perfect impressions for casting.

Instead of using only two flasks in casting any particular pattern, Mr. Bowser forms the mould for the screw in three flasks, two of which contain the upper and lower halves of the mould for the body of the screw, and the third one that for the mould of the head.

A metal plate of size sufficient to cover the end of the two long flasks when placed together, is attached to them, and has in its centre a screw nut which holds the pattern screw in its right position in the sand, at the division of the two halves, to form the required mould.

When the pattern of the body of the screw is to be removed from the sand, a key is introduced into the end of the pattern which passes through the nut, by turning which key the pattern is screwed out of the mould; the nut, which is firmly secured to the plate, affording the necessary resistance.

The plate and nut are then removed, and the third flask, containing that portion of the mould in which the head of the screw is to be cast, is joined to the two long flasks, when the whole is ready for casting.

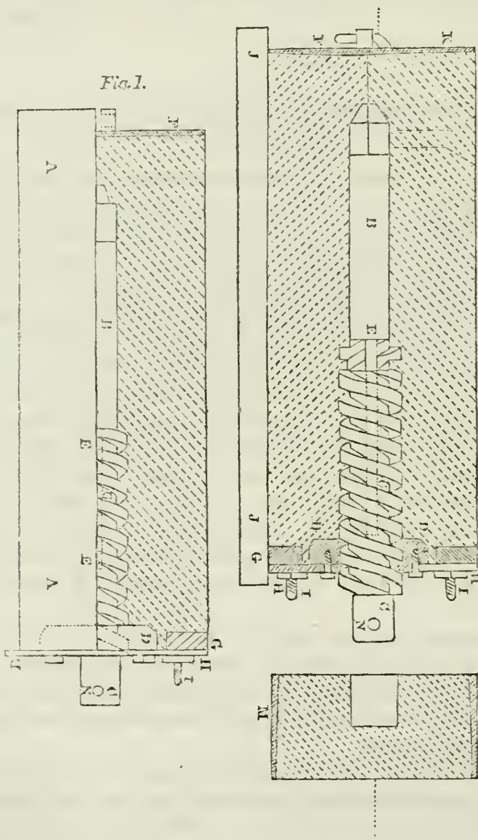
Figs. 1 and 2, exhibit sections of the flasks and screw in the different stages of the process.

A A, fig. 1, is a board prepared to receive half of the pattern screw, by having a hollow formed in it, so that the remaining half projects above the top of the board; B, C C, and D, are the three portions of the pattern.

The portion B, is furnished with a pin E E, which passes into a

cylindrical hole in the screw portion C, and serves to guide the pattern when being screwed out of the sand. The part D, has a hole properly cut to allow of a passage for the pattern to be removed. F G, is part of one of the long flasks shown in section, and placed on the board A A. In the end G, is a semi-circular aperture sufficiently large to allow of the sand being pressed in round the collar D. A metal plate H H, is then screwed to the pattern collar D, and to the flask F G, by two screws I I. Sand is next filled into the flask and rammed solid to the top, as shown by the dotted sloping lines.

Fig. 2.



A second board J J, fig. 2, is now fixed to the top of the flask F G, and the whole being turned over, the board J J, becomes the lowest. The first board A A, is then removed, which leaves half the pattern above the sand. The first half of the mould is then made good if any defects are found in it; and the flask K L, is then placed over and secured to the flask F, and also to the plate H H. Sand is then filled into the top of this flask, and rammed solid as before, which

completes the impression of the body of the screw. The plate H, is next removed in order to attach to the two long flasks, by means of the screws I I, the end flask M M, which is filled with sand to take the impression of the head. This done, the end flask M M, is removed, and the plate H H, is again secured to the flasks F G, and K L, and also to the collar D.

The screw portion of the pattern is now withdrawn by applying a key to the aperture N, and turning the pattern round till it is removed entirely from the sand.

In order to remove the plain portion of the pattern B, the upper and lower flasks are separated from each other, and then all the flasks being once more united, a proper opening is made in the sand, and the metal poured in to obtain the required cast.

Ibid.

Description of a Hook for connecting Catgut Lines used in Machinery. By Mr. Samuel Nicholls.

The ordinary method of connecting the ends of catgut, when used as an endless line for machinery, is, by means of a steel hook and eye, the hollow stem of each being screw-tapped, for the purpose of holding the catgut.

Mr. Nicholls substitutes, for the above arrangement, a double hook C C, and two eyes A B. The catgut is secured to each of the eyes in the ordinary way, and the hook is an independent piece, and somewhat similar in shape to the letter S, except that each hook is at right angles to the other.

The advantages of this arrangement are, that the hook is less liable to jump on the pulley, it affords more play for the twist of the band, and the openings of the hooks being made very small, the eyes are not liable to be unhooked.

Ibid.

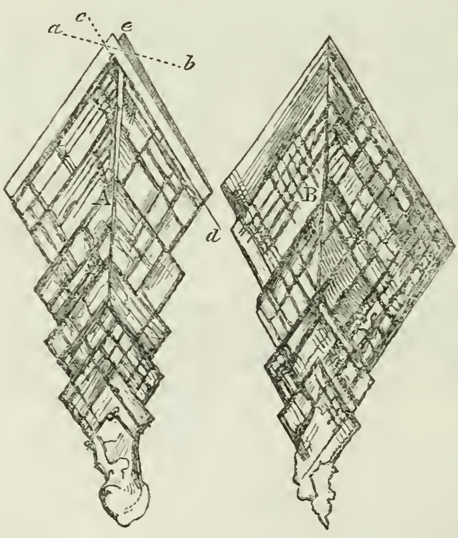
On the change of color in the Biniodide of Mercury. By Robert Warington, Esq.

It is well known that when a solution of the iodide of potassium is added to a solution of the bichloride, or pernitrate, of mercury, a yellow precipitate, passing rapidly to a scarlet, is formed; this is the biniodide of mercury. It is soluble in an excess of either of the agents employed for its production, and if this act of solution be assisted by heat, the biniodide may be obtained, as the solution cools, in fine scarlet crystals, having the form of the octohedron with the square base, or its modifications.

If this precipitated biniodide, in the dry state, be subjected to the action of heat, it becomes of a bright pale yellow color, fuses into a deep amber-colored fluid, and gives off a vapor which condenses in the form of rhombic plates of the same bright yellow; these crystals, by any mechanical disturbance, arising from the unequal contraction of their molecules in cooling, from varying thickness in different parts of the same crystal, or from partial disintegration, return again to the original scarlet color of the precipitate, the change commencing, in the latter case, from the point ruptured, and spreading over the whole of the crystaline mass; they may, however, be freqnently preserved in the yellow state for a great length of time, if sublimed slowly, and not exposed to the contact of other substances, which is readily effected by conducting the sublimation in closed vessels, and allowing the crystals to remain in them undisturbed.

The resumption of the scarlet color has been attribnted to an alteration in the molecular arrangement of the crystals, and it was with the view of clearly ascertaining this point that the following microscopic investigations were undertaken.

Fig. 1.



When a quantity of the precipitated biniodide is sublimed, the resulting crystals are very complicated in their structure, consisting of a number of rhombic plates, of varying size, superposed, sometimes overlapping each other, and causing considerable variableness in their thickness, but generally leaving the extreme angle, and the two lateral edges clear and well defined; the annexed sketch, taken by the camera lucida, from the field of view of the microscope, will give a better idea of their character. The length of these crystals was about .015 of an inch. On cooling, the first change that is observed is usually a scarlet marking, commencing at the extreme

angle, and extending gradually inwards, always retaining a perfectly well defined line in its progress; when this change has reached as far as the line *a b*, fig. 1, the scarlet line will suddenly shoot along one of the lateral edges, as shown at *c d*, and instantly the whole mass is converted, in a most rapid and confused manner, which the eye in vain endeavors to follow, to the scarlet color, the crystal being frequently, if detached, twisted and contorted during the transition.

In order to obtain these crystals in a more defined and clearly developed form, a small glass cell was constructed of two slips of window glass, leaving a space of about the thickness of cartridge paper between the upper and under plates, in which the sublimations could be readily conducted, and the whole of the subsequent changes at once submitted to the microscope; by this means beautifully well defined and perfect crystals were obtained having the form of right rhombic prisms, as in the accompanying outline, fig. 2, *a* and *b*. The following interesting phenomena were then observed: a defined scarlet line of varying breadth would shoot across the crystal, as at 1, *c*, *d*, *e*, *f*, fig. 2, and then gradually spread throughout the whole of its structure, keeping a straight and well defined line in its onward progress, until the whole had undergone the change of color. Nos. 2, 3, 4, 5, in *e*, and No. 2, in *f*, are the stages which the transition had reached at intervals of observation; in many cases, after the crystal has undergone this metamorphosis, two angles can be distinctly seen, as at *e*, fig. 1, and at times two edges are visible, as at *c* 6, and *d* 6, fig. 2. This observation must, of course, depend entirely on the position of the crystal to the eye of the observer.

Fig. 2.

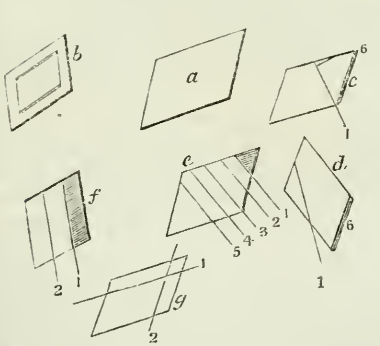
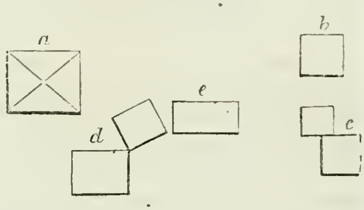


Fig. 3.



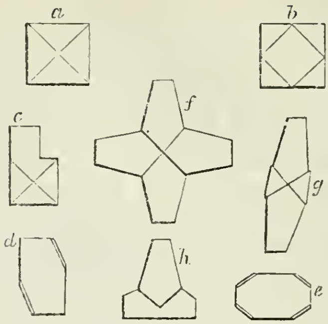
These phenomena prove, I consider, in the most perfect manner, that the change in the color of this compound arises from the plates of the crystal having been separated from each other, by the means alluded to, in the direction of their cleavages; and in further confirmation of this view, the laminæ, so separated, may, by the sudden application of heat, be again fused together, and the yellow color reproduced without materially altering the dimensions of the crystal, a slight rounding of the edges from partial sublimation being the only other concomitant.

When the temperature is raised slowly, and the sublimation conducted with great care, a very large proportion of red crystals, having a totally different form, are obtained, the octahedron with the square base, as shown in fig. 3, *a*, *b*, *c*, *d*, *e*. If, however, the heat is quickly raised, the whole mass of the sublimed crystals are yellow, and of the rhombic form. It is evident, from these facts, that the biniodide of mercury has two vapors which are given off at different temperatures, and also that it is dimorphous, which facts have been substantiated by some experiments of M. Frankenheim, who has carefully examined this part of the subject.

From the circumstance that the first effect which occurs in the process for preparing this iodide, by precipitation, is the production of a yellow powder which passes rapidly through the orange color to a scarlet, I was induced to submit this phenomenon also to the test of microscopic examination, and with this valuable instrument of research, results were exhibited which could not have been anticipated. As I expected, the precipitate was in small crystaline grains, and the first step of the investigation was to effect its formation in the field of view of the microscope, so as to observe, directly as they occurred, the transitions of color which have been alluded to, and this was effected by the following means:—A slip of common window glass, about three inches long by one and a half wide, and having a very narrow slip attached on one of its edges, so as to act as a ledge, was taken, and a drop of the salt of mercury employed, placed on it; this was then covered with a small piece of extremely thin glass, about one inch long by half an inch wide, and the whole carefully adjusted to a focus in the field of the instrument; the iodide of potassium was then introduced by capillary attraction between the glasses. The instant the solutions came in contact, a myriad of pale yellow crystals, having the same rhombic form as those obtained by sublimation, formed in a curved line across the field of view, and extended slowly downwards; by the strong transmitted light, these minute crystals appeared colorless; but when viewed by reflected light, the pale yellow color was readily apparent. After a short interval a very extraordinary change commenced; the crystals, which had been perfectly sharp and well defined, became ragged at their edges, as though some dissolving action were going on, gradually decreased in size, and at last disappeared altogether; but as this act of solution progressed, numbers of red crystals made their appearance, forming across the field, and following, at a regular distance, the yellow crystals as they disappeared, and occupying their place. These red crystals, which appear to be formed by the disintegration through the medium of solution, if I may be allowed the expression, from those first produced, had the form of the octahedron with the square base, exactly similar to those procured by careful sublimation at a low heat, only modified in the most beautiful manner. Some few of these are sketched in the forms *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, fig. 4. When either the salt of mercury, or the iodide of potassium, employed in the production of the biniodide of mercury was in excess, another curious act of disintegra-

tion took place; the red crystals in fig. 4, were slowly dissolved, a property mentioned in the first part of this paper, the first act of solution commencing apparently by the disjunction of the crystals *a*, *b*, *c*, *f*, *g*, *h*, at the lines of marking, these lines being at first bright red, and gradually deepening in color when the act of solution commenced, and at last perfect separation taking place, so that the light could be seen between the compartments. At times the field would become dry from evaporation, and some of the yellow rhombic crystals which had not been dissolved, prior to the formation of the octahedra with the square base, were observed with scarlet lines on them similar to the first act of transition in the sublimed crystals, as shown at *g* 1 and 2, in fig, 2.

Fig. 4.



By polarized light the appearances now described were beautiful beyond all description, the yellow crystals presenting the most superb and brilliant colors, varying in hue with the varied thickness of the crystaline plate, and in the dark field having the appearance of the most splendid gems the imagination can conceive: the red crystals do not appear to be affected by polarized light, so far as the display of color is concerned.

The magnifying powers used in these investigations, were, for the experiments on the sublimed crystals, 200 times linear measurement, or diameters; in the precipitated compound, 620 diameters.

Mem. Chem. Soc., Lond.

On the Progress made in the Application of Electricity as a Motive Power. By W. R. Grove, Esq.; *read before the Royal Institution, February* 9, 1844.

The subjects of Mr. Grove's communication were, first, a brief summary of the laws of the electro-magnetic force; second, a description of the chief modifications of the engines to which that force has hitherto been applied; third, the commercial statistics of its application; fourth, the purposes for which this power is available. In dealing with the first of these subjects, Mr. Grove exhibited, by many illustrative and successful experiments, the well known re-actions of iron and other metals on each other, when exposed to the influence of an electric current. The actual application of these familiar phenomena, was then shown in the working models of several machines, which were set in action by the nitric acid (or Grove's) battery, invented by Mr. Grove, and described by him four years ago at the Royal Institution. These machines may be divided into three classes, first, those acting by the immediate deflecting force, as shown in the

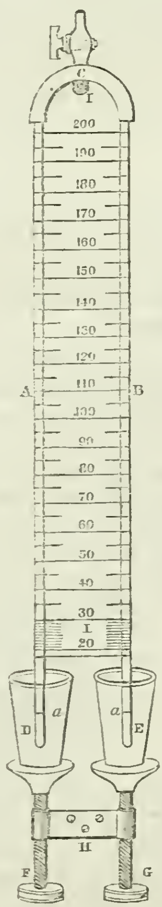
galvanometer, Barlow's wheel, &c.; secondly, those on what is called the suspension principle. In these, two powerful electro-magnets are fixed contiguous to the periphery of a wheel, and in the line of its diameter, plates of soft iron being fastened on this pheriphery at short and equal intervals. The electro-magnets are so arranged as to lose their attractive power as soon as they have drawn through a given space each plate of iron, necessarily presented to them by the revolution of the wheel, but are immediately afterwards re-invested with this power, in order to operate on the next plate. By these means the wheel is kept in constant rotation on its axis. The remaining class of electrically driven machines are applications of the principle of Ritchie's revolving magnet. In these, an electro-magnet, balanced on a pivot, so as to rotate in a horizontal plane, is arranged between the poles of a permanent magnet. Hence, the alternate attractions of the opposite magnetic poles, combined with its own momentum, cause the electro-magnet to continue rapidly revolving. Having noticed machines, on these various principles, by H. Fox Talbot, Esq., Mr. Hill, of Swansea, and Professor Wheatstone, Mr. Grove proceeded to his third subject, the commercial statistics of electro-magnetic power. It appears, by the experiments of Dr. Botto, that the consumption of 45 lbs. of zinc will produce an effect equivalent to a single horse power for twenty-four hours. The cost of the metal, at 3*d.* the pound, would amount to 11*s.* 3*d.* About 50½ lbs. of the nitric acid of commerce would be required to dissolve the metal in the most economical and effective manner. The charge of this, at 6*d.* the pound, would be 1*l.* 5*s.* 6*d.* The whole expense, therefore, of obtaining the effect of a one horse power by an electro-motive apparatus, would be 1*l.* 16*s.* 9*d.* In this calculation, the cost of the requisite sulphuric acid is assumed to be fully covered by the value of the salts of zinc produced in the operation. The same amount of power produced by a steam engine would not cost more than a few shillings. Mr. Grove explained that this comparative costliness of the electro-magnetic machines resulted from the sources of their force, zinc and acid being manufactured, and, consequently, costly articles; whereas, coal and water, the elements of the steam engine's force, were raw materials, supplied at once from the earth. Mr Grove took this occasion to observe, that the experiments of Botto, just alluded to, were made with his (Grove's) battery; and that upon the cost of the constituents of this, the calculations were founded. At first sight, this battery would appear a dear form, from the expense of the nitric acid; but a little consideration proves the contrary of this. Compare it, for example, with a battery merely charged with dilute sulphuric acid, the cheapest possible electrolyte, to perform an equivalent of work, as the decomposition of a given quantity of water, a series of three cells of the ordinary battery is necessary; hence the consumption of three equivalents of zinc, and three of sulphuric acid. But the intensity of the Grove's battery is such, that the same resistance can be overcome by one cell, consuming only one equivalent of zinc, one of sulphuric acid, and one-third of nitric, there being in this acid three available equivalents of oxygen. Independently of this smaller consumption, Grove's

battery has the advantage of occupying only one-sixteenth of the space of the other constructions. In concluding his communication, Mr. Grove mentioned the two well known applications of electric power—the electric telegraph, and the electric clock. To neither of these can steam, or, indeed, any known force, be so applicable as that which travels with a greater velocity than light itself.

London Athenæum.

Description of an Instrument for Ascertaining the Specific Gravity of Fluids. By JOHN HAM, ESQ., Civ. Eng.

I beg to forward, for insertion in your highly popular publication, the drawing of an apparatus for readily ascertaining the specific gravity of fluids, which I devised some months since, and find extremely useful in practice.



By having the scale minutely divided, or adapting to it a vernier, it is susceptible of a high degree of accuracy, and for all ordinary fluids, is infinitely superior to the gravity bottle and balance, and in many instances preferable to the common hydrometers, especially in commercial transactions, where rapidity and accuracy are essential points.

A and B, are two glass tubes, from $\frac{1}{4}$ to $\frac{3}{4}$ths of an inch bore, and of any convenient length; about 2 feet will be found sufficient for usual purposes; C, a connecting brass tube and stop-cock; D and E, two glasses, one for distilled water, the other for the liquid whose specific gravity is required; F and G, two milled headed screws, carrying each a stand for one of the glasses; H, a bracket with two nuts for supporting the screws and stands, F G; I I, the scale, divided into 200, or 2000, equal parts, or degrees.

The mode of using it is simply this: Pour distilled water into one of the glasses, and the liquid to be tried, into the other, both at 60°, or any

moderate *uniform* temperature. Exhaust the air in the tubes—either by means of a syringe, or the mouth being applied at the stop-cock C—until the lightest fluid is nearly at the top of one of the tubes; then bring the surfaces of the two fluids, in the glasses E and E, on a level with the marks *a a*, on the tubes, by means of the screws, raising, or lowering, the stands as required; the heights of the fluids in their respective tubes will immediately give their relative gravities, convertible into water at 1000, by simple proportion.

Lond. Mech. Mag.

[Note.—We insert the above in the hope that it may be found of interest to some of our readers, as well as to protest against the constant reproduction of *worn-out* novelties in the journals. The machine here described forms part of the apparatus of almost every physical lecture-room. Among the Apparatus of the University of Pennsylvania, is a very beautiful instrument of this kind, made by Lerebours, of Paris, and so entirely like the drawing, that it might be supposed to be the identical model. This has been in the possession of the University for, at least, ten years; so that the thing is, or ought to be, as well known in Europe, as it is here.

Com. Pub.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Hydraulics.—General Sketch of a Theory of the Contraction of Veins in Water discharged from Orifices in thin Plane Walls. By M. Bæyer.

In comparing the different experiments upon the flow of water from vertical openings in thin plane walls, we are struck by the great variation undergone by the coefficient by which, in each case the theoretic formula for the discharge must be multiplied. On examining the facts more strictly, we find two sorts of distinct variations, of which one depends solely upon the amount of the charge, and the other upon the form of the orifice. The existence of the first is a certain sign that the formula used does not accord with the experiments. The second proves that the water of the reservoir is subject to a law of motion, the effect of which is modified by the form of the opening. While reflecting upon these difficulties, I was struck by a very simple idea, and one which deserved a rigorous investigation. This investigation is the subject of my memoir. To present the results in a proper light, I will here give, in a concise manner, the sketch of my work. I assume hypothetically, that the molecules of water in the reservoir, move towards the centre of the orifice, with velocities which are inversely proportional to the square of their distances from that centre. Hence it follows, that molecules equi-distant from that centre will have the same velocity, and are situated upon the circumference of a hemisphere described from that centre with a radius equal to, or greater, than that of the orifice. As soon as the molecules have arrived at the hemisphere described with the radius of the orifice itself, their velocity is decomposed into two others, of which one is

parallel to the axis of the orifice, and the other perpendicular to this axis. The first gives the velocity perpendicular to the plane of the orifice, and the other represents the velocity of contraction. But in order to determine, in conformity with the hypothesis adopted, both of these velocities, it is required to find the mean distance from the plane of the orifice, of the particles in the section of a hemisphere passing through its axis; that is, the mean distance of the molecules upon the periphery of a semi-circle of the same diameter. We arrive, by this means, for circular orifices, at results conformable to those of the experiments of Bossut, Poleni, Eytelwein, &c. By this examination we find, for the orifices in question, the variation in the discharge dependent upon the form of the orifice; nothing more is wanting than to seek for that which depends upon the charge, or to determine the true velocity of discharge, which is done by the known methods. Thus, in determining the coefficient of contraction (k) of vertical rectangular orifices, we arrive at the general formula,

$$k = \frac{l}{b}.0.1140449 \frac{(m+\sqrt{\pi})^{\frac{3}{2}} - \left[m + \left(1 - \frac{b}{l}\right)\sqrt{\pi}\right]^{\frac{3}{2}}}{\sqrt{m+1}\left[\frac{1}{2} - \frac{1}{64(m+1)} - \dots\right]}$$

Where l, is the base of the rectangle, b, its height, π, the ratio of the circumference of a circle to its diameter; m, is determined by means of the equation $m = \frac{(H-a-l)\sqrt{\pi}}{l}$, where H is the charge above the loweredge of the rectangular orifice, a, is the height of a column of water equivalent to the difference of the atmospheric pressure upon the surface of the water in the reservoir, and upon the centre of the orifice. This value taken for the following table is equal to 0.0020 metre.

In order to show the correspondence of the formula with observations, I have compared it with the admirable experiments made by M. Poncelet, et Lesbros, at Metz, in 1828; calculating only the coefficients of the first experiments in the six tables, from No. 4 to No. 9, I get

Number of the Tables.	Charge above the lower edge, H.	Sides of the Rectangular Orifice.		Value of the Coefficient, k.		Difference.
		Ver. side. b.	Hor. side l.	Observed.	Calcul'ed.	
	Metres.	Metres.	Metres.	Metres.	Metres.	
4	1.5720	0.20	0.20	0.6026	0.6034	— 0.0008
5	1.6054	0.10		0.6111	0.6135	— 0.0024
6	1.7151	0.05		0.6175	0.6180	— 0.0005
7	1.3960	0.03		0.6229	0.6225	+ 0.0004
8	1.4102	0.02		0.6217	0.6234	— 0.0017
9	1.4070	0.01		0.6204	0.6246	— 0.0042

These differences do not exceed those which the results of experiment several times repeated, show. The calculated values of k, are

found a little too large, because all the other small corrections have been neglected, such as the friction on the edges of the orifice, the temperature, the resistance of the air, &c.

In the memoir I have employed an approximative formula, which differs very little from the exact value, and which is formed by supposing that the velocities, in rectangular orifices, are as the square roots of the charges above their centres.

All these formulæ, however, suppose that the level in the reservoir remains constant, which is not the case in practice, except when the charge is ten, or twelve, times greater than the radius of the orifice. In small charges there is a depression of the level above the orifice, for which allowance must be made, in order to obtain exact results; for this reason it is necessary to multiply all the formula by a factor which depends upon the depression; by this means I obtain equations which are applicable, at the same time, both to great and small charges, and even to overfalls.

Finally, the different forms of the veins of water are determined by means of the theorum mentioned above, that the force of contraction is proportional to the radius of the orifice. Hence it follows that the contraction in the diagonal sections of a square orifice is greater than that in the sections passing through the centres of parallel sides, and as the contraction may be regarded as a force acting perpendicularly upon the axis of the vein, it follows that the particles of water in the larger sections approach the axis, whilst the particles, in the smaller sections, are farther from it, which explains the forms found by experiment.—*Comptes Rendus, 15th January,* 1844.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Report upon a Note relative to the Flexure of Beams Loaded in a Vertical Position; presented June 20th, 1842. *By* M. E. LAMARLE. *Committee, Poncelet and Lionville.*

In this note M. Lemarle has chiefly proposed to establish the following principles:—

1. The loads, which beams, loaded vertically, can support without permanent alteration, are independent of their lengths, and simply proportional to their sections, so long as the ratio of their lengths to the least dimension of their transverse section does not reach a certain limit.

2. Beyond that limit, and in all cases of practical application, the maximum load may reach, but can never exceed, the pressure corresponding to the initial flexure.

M. Lamarle also shows that (the pieces being supposed prismatic,) it is sufficient to know the greatest change in length compatible with the preservation of elasticity, in order to determine numerically the limit alluded to. He remarks beside that the results furnished, by calculation, accord with the facts generally observed, and that they imply the consequences announced by M. Duleau, in the following terms: "A rectangular bar pressed vertically, resists until the com-

pressing weight attains the value, $Q=\frac{\pi^2 c}{4a^2}$. This weight causes the piece to assume a curvature in the direction of its smallest dimension, and it at once folds together." The deductions of the author rest essentially upon the analysis given by M. Lagrange, for the problem of the flexure of pieces loaded vertically, but by imposing the condition of not surpassing the force capable of producing a permanent alteration, and by expressing this condition numerically, M. Lamarle has introduced into the question an element of which advantage had not yet been taken to solve it practically. The introduction of this element fixes the degree of convergence of the series which are obtained, and permits the deduction from the general solution, of rules valuable to the builder.

We know, and Lagrange has proved, that the flexure of pieces pressed vertically, becomes possible only when the pressure has obtained a certain minimum value. If the pieces are prismatic, the load corresponding to the initial flexure, increases in the inverse ratio of the squares of their lengths. The contractions which it produces, independent of all flexure, are, therefore, more considerable in reference to the unit of length, in proportion as the pieces are stouter, and we may conceive that for a given cross section there exists always a length below which there is already an alteration of elasticity, even when the load is too small to cause a commencement of flexure. Hence the first principle announced by M. Lamarle.

Let us now consider the case of flexure, and let us suppose the ratio of the length to the smallest dimension of the cross section to be so great, that flexure may commence before a permanent alteration has taken place. In this case the strain *due to the effect of flexure alone*, increases as the versed sine; and M. Lamarle shows that an almost imperceptible increase of the pressure corresponding to the initial flexure, is sufficient to cause an instant alteration of the elasticity. Hence the second principle of the author, not absolute, but sufficiently general to include all the cases which might escape the first, under the circumstances usual in practical applications.

These two principles taken together, offer a satisfactory solution to the question of beams loaded vertically.—*Comptes Rendus, 15th January*, 1844.

On Madder. By M. Girardin, *Prof. Prac. Chem. at the Municipal School of Rouen.*

In commerce the name of *Lizari* has for a long time been restricted to the entire roots of the madder, while that of *Madder* is applied to the pulverized roots.

The Lizaris are very little employed for the purposes of dyeing, and there is hardly any but the Lazari of Avignon, which is met with in the markets of France. The Lizari of Cyprus is actually of rare occurrence; that of Alsatia is never met with.

The powders called *madders* are distinguished according to their

origin, into *Dutch Madder*, *Alsatian Madder*, and *Madder of Avignon*, or of the *Comtat.*

Up to the present time no one of the numerous works which have been written upon this subject, no work of Materia Medica, or of applied botany, has given the history of these powders, nor the peculiar characters of each variety; I shall endeavor to supply this want by giving a detailed description of the three kinds of madder met with in commerce. My situation has enabled me to make a particular study of this important tinctorial product; and the following remarks are the result of many and various observations:—

I.—*Dutch Madder.*

The Dutch madder, which was formerly extensively employed in France, has almost entirely disappeared from our markets, from the heavy duty which the government purposely put upon it, in order to maintain and encourage the cultivation of that of Alsatia, and of the Comtat. This madder possessed a well deserved reputation, and there is no doubt but that it would again be generally used, if the duty, which is equivalent to a prohibition, were to be reduced. The following are its distinctive characters:—Its odor is strong and nauseous; its flavor is sweet, with a mixture of bitterness; its color varies according to the marks, and passes from a brown-red to an orange-red.*

In general its powder is stringy *(en paille)* that is to say, its state of division is sufficiently large to exhibit the structure of the root. It is coarser than the powder of the other kinds of madder, which might be attributed to negligence, since frequently portions of Lizari are met with which have not yielded to the grindstone. This coarse state of comminution, however, is no defect, since it prevents fraud. This powder appears greasy to the touch. Exposed to the action of the atmosphere, it readily absorbs moisture, and when, for the sake of ascertaining its quality, it is exposed to a moist air, its orange-red changes to a bright red, of a rich depth of color. The Dutch madder *works* more than the others, according to the commercial term, *i.e.* it presents more decided modifications of color by exposure to moist air.

Dutch madder is *stripped*, or *not stripped.* In the first case, the roots have been freed from their epidermis, which gives greater brightness to the powder; in the second, they have been triturated without undergoing this operation, when the powder is of a more sombre color. This madder cannot be used while fresh; it must be a year in the cask, at least. After three years it is in full vigor.

The *pale* powder, or of a yellow aspect the first year, soon undergoes fermentation with age; the divided parts then unite with each other, agglomerate, and increase in volume to such a degree, that,

* The red-brown tint is only applicable to the *mulle* madder of each kind. The term *mulle*, or *billon*, is applied to the inferior quality of madder. It is a mixture of the smallest roots, of the fibres, and of the epidermis of the large roots, of earth, and of the bran, or refuse, of the sieves.

after several years, the dilatation is so great that the bottoms of the casks present a very marked convex form. The madder is then so hard, that in order to take it out of the cask, a mallet, or chisel, must be used. This madder ferments more than the others.

It keeps several years after having attained its greatest tinctorial power, (about three years) after which the layers which line the sides of the casks, begin to lose their brightness; the madder assumes a pale brown color, and it enters into decomposition. The progress of this is slow but certain; it subsequently becomes quite extinct, and the madder has a brown-red color.

In its decomposition it may still be used for brown grounds, or colors; but when age has destroyed all the coloring principle, it can only serve as *mulle.*

The marks current in our markets are

Mulle O, . . .	or	Mulle.
Superfine, . . .		Fine grappe.
Not stripped, or stripped, .		Superfine grappe.

This word *grappe* (bunch) is employed when age has given consistence to the powder. The term *grappe* is used to designate its state of agglomeration.

This kind of madder formerly came from Holland in oaken casks of the weight of 600 kilogrammes.

II.—*Alsatian Madder.*

This madder, which has replaced the Dutch in our manufactories, although it does not possess all its qualities, has the following characters:—

The smell is less decided, more penetrating than that of the preceding; taste less sweet, equally bitter; color brown to bright yellow, according to the mark; state of division, coarse. It easily absorbs moisture from the atmosphere; by long exposure it changes from yellow to a dark red; in use, however, it inclines more to yellow.

As is the case with the Dutch madder, it is not employed while fresh; it is in full vigor when two years old. It deteriorates sooner than the former; its fermentation is less decided; it grows very hard, however, in the casks, coheres to the very centre, and there is the same difficulty to extract it. The progress of decomposition is the same; the madder which has undergone this process can only be used for dark tints.

The Alsatian madder is never known by the denominations of *stripped,* or *not stripped,* although the operation of *stripping* takes place. The marks alone distinguish the varieties. The marks known in our markets are

O, Mulle.	SF, Superfine.
MF, Mi fine.	SFF, Superfine fine.
FF, Fine fine.	

The most generally used is FF.

SFF, is nearly an exception to the method employed by the Alsatians in grinding, who are strict enough in their marks to be unwil

ling to prepare a very fine quality, which would be to the injury of the preceding.

The madder of Alsatia is packed in oaken casks, or hogsheads, of 600 kilogrammes, in half hogsheads of 300 kilogrammes, in quarters of 150 kilogrammes, and in barrels of 100 kilogrammes. All these hogsheads are similar in form, and only differ in size.

It is at Strasburg, Hagenau, and Geisselbrunn, that the so called Alsatian madder is manufactured.

III.—*Madder of Avignon.*

The madder of Avignon is most generally used at the present time, and even preferred to the other kinds, because the dyer and cotton printer find it easier, by using it, to vary the reds according to wish. It is especially since the peace of 1815, that the use of this madder has greatly increased.

Of all the kinds of madder this is the sort which has undergone the most modification; I may say, almost the only kind in which variations have been made in the marks, and in the quality. In Holland and in Alsatia, the quality specified is generally conformable to the mark. In Avignon, on the contrary, each manufacturer has a mark to designate its quality; and the mark SFF, which with one is beautiful, is but middling with another. The result is, that the trader cannot trust to the mark alone, which presents a different tint in each manufactory. The madder of Avignon, therefore, can only be bought after having been spread out to view upon linen.

The characters of this powder are, odor agreeable, slightly penetrating; taste sweetish bitter; color either rose, bright-red, or brown-red, according to the roots employed in the preparation, and to the degree of mixture; state of division very fine; powder dry to the touch.

When submitted to the action of the atmosphere, it absorbs moisture less readily than the other species; however, it does not work less, and subsequently affords a pale, or very dark, red, according to whether the powder operated on was *rosy*, or *palus*.

In Avignon they are not acquainted with the terms *stripped*, or *not stripped*, *(robée ou non robée.)* There the word *épuration* is used. A madder is purified from 3, 5, 7, or 10, per cent., and even as high as 15 per cent. This mode of expression is pure quackery, for how is a root to be purified except by depriving it of its epidermis, and how can we suppose that the root may contain at will so much more, or less, of it, as to require that the purification should sometimes be carried to 15 per cent.? We should have to suppose that the weight of the epidermis was to that of the root as 1:7, 10 or 15, which is not the case.

The best madder is made with the roots of the Palus. In Avignon the name of *Palus* is given to some tracts of land anciently covered with marshes; these lands, enriched by animal and vegetable remains, are eminently suited for the cultivation of the madder, and the roots they produce are almost all *red*, whilst other kinds of soils produce rose colored roots.

The powder from the Palus madder is of a dull and rather unsightly red, but on drying it becomes blood-red, which may be varied at pleasure. A small quantity goes much farther than a larger quantity of the *rose colored* root.

The *rose colored* madder is made with the so called *rosy* Lizaris. The powder is of a bright red, bordering a little upon yellow.

The madder, which is half *palus*, half *rosy*, forms a brilliant powder, which is well received in the market, and which affords very satisfactory results in dyeing. The brilliancy of the *rosy* madder mingling with the rich depth of the palus, produces a most beautiful red.

The madder of Avignon may be used immediately on leaving the mills; but the powder which has been preserved in casks for a year is decidedly preferable. It keeps well, and undergoes little, or no, fermentation in the casks; it does not cohere in a mass; after several years, however, it is decomposed with nearly the same symptoms as the other kinds: it is still used in this state. The small degree of fermentation evinced by this madder, arises from its containing much less mucilaginous, saccharine, and bitter substances, than the Dutch and Alsatian madder, for it is certain that the acid fermentation which is so energetically developed in the latter, must be attributed to those substances.

Although pressed with great force into the casks, the madder retains a certain quantity of air between its particles, which, in time, acts upon the whole mass, and gives it a uniform color, by oxidizing the primitive yellow coloring principle, and changing it into a red principle. This theory, advanced by M. Decaisne, very well explains why the madder powders are improved in quality by being preserved for a certain time in the casks.*

The drying of the roots in the stove has great influence on the tint of the madder of Avignon. If dried at too high a temperature, the powder is dull, without, however, losing in quality.

At first only two kinds of Avignon madder were known, the *yellow madder*, and the *red madder*. The first has since disappeared, and the *rosy madder* is now substituted for it.

As to the marks, it is difficult to give positive information on the subject, especially since quackery has endeavored to deceive by extraordinary names. Originally only the following marks were known:

Mulle.
FF, Fine fine.
SF, Superfine,
SFF, Superfine fine.

These marks were put upon the casks without other designations. The tint alone decided to what sort of root the powder belonged. At present the madders are either—

Palus, or
Rosy, or
Half Palus, half rosy.

* Anatomical and Physiological Researches concerning the Madder. By M. Decaisne; 1 vol. 4to.: Brussels, 1837.

When it is wished to denote that a madder is all *Palus,* a P is added to the mark. The following are the actual marks:—

Mulle, without distinctive marks.

FF	To each of these marks the letter
SFF	P is added for Palus,
SFFF	R for Rosy,
EXTF	PP for Pure Palus,
EXTSF	RPP for Pure Red Palus,
EXTSFF	Half Palus, Half Rosy, without distinction.

According to these designations, it is by no means rare to find the absurd marks of

EXTSFRPP,

which is to be understood thus:—

Extra Superfine Fine Pure Red Palus.

It must be confessed that such absurdities can only exist in a country where fraud has made revolting progress. It often happens that the mark EXTSF, now used, is not equal to the old one of SFF.

The *extra fine* is especially manufactured with the heart, or the ligneous part, of the root. This mark gives less depth, because the ligneous part is less rich in coloring principle than the fleshy part, or the bark, of the root, but it affords a much more lively color. The madders of Avignon are packed in deal casks of 900 kilogrammes in weight. The insides of these casks are generally lined with very thick pasteboard, in order to prevent contact with the air, which blackens the powders, causes them to appear less beautiful, and after a certain time destroys much of their tinctorial properties. Light also very quickly changes the coloring principle of these powders.

It is rather difficult to ascertain exactly the quantity of madder gathered each year in France, as well in Alsatia as in the ancient county of Venaissin.

In 1837, the crop of the Lizaris amounted, in these districts, to 1,200,000 kilogrammes, which is equivalent to from 48,000 to 50,000 barrels, of which part was sent to the different places where it is consumed, as well within as without the country, conformably to the following table:—

	Kilogrammes.
Rouen, Havre, and Dunkirk,	3,800
Antwerp,	500
Genoe and Leghorn	183
London, Liverpool, and Glasgow,	3,760
London, Liverpool, and Glasgow, 8000 bales of lizari, which represent	3,500
Hamburgh,	530
St. Petersburgh,	1,608
Odessa,	110
Rotterdam,	423
Trieste,	205
New York and Boston,	812
Mulhausen, Strasburg, Metz, and Basle, for the consumption of Alsatia, Prussia, Switzerland, Bavaria, Austria, &c.,	15,000
Total,	30,481

There remained, therefore, of the harvest of 1837, at Avignon, and in the department, from 18,000 to 20,000 barrels, when the harvest of 1838 was about to be got in. This, although less than the former, amounted to between 36,000 and 40,000 barrels.

The manufacture at Avignon is always in a prosperous condition. The state of the customs shows that in 1840 there was exported from France 2,161,158 kilogrammes lizaris, which represent in value 1,620,869 francs, and 12,114,054 kilogrammes of madder, equal to 12,114,054 francs; that in 1841 there were exported 1,896,416 kilogrammes of lizaris, equal to 1,422,312 francs, and 11,840,886 kilogrammes of madder, equal to 10,840,886 francs.

The importation of foreign lizaris and madders is very small, on account of the heavy duties. The lizaris chiefly come from the Levant by way of Turkey, the Barbary States, from Tuscany, the two Sicilies, and from Germany. The madders come especially from Holland and Belgium.

IV.—*New Commercial Products derived from Madder.*

Since 1836, two new products occur in commerce, which are destined to replace madder in the operations of dyeing and calico printing. One is known by the name of *garancine,* the other by the name of *colorine.*

A. The *garancine* is a more, or less, clear chocolate colored powder, without any decided smell, or taste; it does not impart any color to the saliva, or to cold water even by long contact.

This garancine is nothing further than the *charbon sulphurique* of MM. Robiquet and Colin,* deprived of every trace of acid. A patent was taken out on the 26th of March, 1828, by MM. Lagier, merchant, and Robiquet and Colin, Professors of Chemistry, for the manufacture and sale of this new product. As the specification which contains the description of the process of manufacture has never been published in any scientific work, I think it right to notice it in this place.

"The problem to be solved," says the patentees, "is to obtain the whole of the coloring matter of the madder free from the foreign bodies which tarnish its lustre, and retain it in combinations different from those which it ought to contract with the mordants; now the madder in its natural state contains coloring matter in various conditions. Thus in the dyer's bath it separates into two portions, one of which is either dissolved, or suspended, in the water, whilst the other remains fixed in the ligneous residue. In treating the exhausted residue, which is generally considered worthless, by the method described below, a quantity of coloring matter, at least equal to that first extracted from it, is obtained. Besides, the portion which the water carries with it, either in solution, or in suspension, is far from being attracted by the mordant of the stuffs immersed in it. A great part remains in the bath, in combination with some substances which retain it with sufficient energy to prevent it from combining with the mordants beyond a certain limit."

* Société Industrielle de Mulhausen, t. i. p. 162.

The following is the process proposed by them:—"The madder is immersed in from 5 to 6 parts of cold water, and allowed to macerate all night, in order that the portion of the coloring substance which dissolves at first, may have time to subside; the whole is then thrown on to linen strainers, and when the liquid has passed through, the grounds are pressed; they are then immersed again in the same quantity of water, pressed, and this operation repeated once more. After these three washings, which serve to remove a green substance, besides sugar, mucilage, and other soluble substances, the grounds, still moist and well crushed, are mixed with sulphuric acid equal to half the amount of madder first employed; it is, however, requisite that this acid should be diluted more, or less, with water according to the temperature; this is done when it is about to be employed, in order to turn to account the heat set free by the mixture. The acid thus diluted is poured quite hot over the madder; it is then agitated as rapidly as possible, and when the mixture is thought to be well effected, the temperature is raised to 212° Fahr., and maintained for about an hour. At the end of this time the substance is again mixed with a suitable quantity of water, filtered, and washed on the strainers until the liquid passes off perfectly insipid. It is then pressed, dried, and passed through the sieve.

"In this operation the acid has undergone no alteration; it has merely become weaker, and charged with some calcareous salts, which does not prevent its being employed in the manufacture of sulphate of soda. The first washing water might also be turned to account, since it contains much sugar, which might easily be converted into alcohol."

Garancine was first introduced into commerce by the house of Lagier & Thomas, of Avignon, towards the year 1829, who had bought the process and the patent of Robiquet and Colin; but this product did not meet with success in the market. The neutral state in which it was delivered not affording any correction to the calcareous waters ordinarily used in our Rouen print works, and the action of their alkali on the coloring principle not being properly understood, the experiments which were made with it on a large scale were far from corresponding to those made with smaller quantities, and threw it into great discredit. It was not until later (in 1832) that the same house in Avignon, assisted by the advice of chemists, again commenced some trials, the results of which proving satisfactory, led to the belief that its use might become of importance. At this epoch, however, the madder prints in vogue, being very dark, and requiring a strong dye, could not be produced with garancine; the great quantity of coloring matter which they required, prevented its use on account of its price; but in 1835, the issue of certain kinds of colored prints requiring very bright colors, again drew the attention of manufacturers to garancine, and it was generally adopted and approved of.

Many persons, forseeing how important its consumption might become, started establishments for the manufacture of it on the expiration of Robiquet's patent granted to Lagier & Co. Want of expe-

rience in this process caused these first manufacturers to obtain but imperfect products, and many soon left off; but shortly after, some persons, profiting by the experience of their predecessors, again took it up, and there are now from twelve to fifteen manufacturers of garancine at Avignon, and one or two in Alsatia.

The manufacturers of Avignon employ only the madder of the Comtat; those of Alsatia are, it is said, obliged to add a small quantity of the former to the madder which they grow, in order to increase the quantity of coloring matter of their garancine.

From 1839, this substance began to be generally employed in several of the principal print works of Rouen, among others by M. Schlumberger-Rouff, who manufactured the garancine which he used according to the following process:—

After having ground the already pulverized madder on a table, by means of a thick, wooden rolling pin, such as is used by pastry cooks, it is placed in a leaden basin, then moistened with a little water, and half its weight of sulphuric acid of 1.834 sp. gr. poured over it, whilst two men continually stirred the mass with shovels, walking around the basin. When the burning *(brûlage)* was ended, it was washed five, or six, times in barrels, the product drained upon linen, and then dried in a chamber heated by steam. It was afterwards ground in a water mill, made upon the plan of pepper, or coffee, mills. This garancine was very acid, and could not be used for violet colors. It cost 3 francs 75 centimes the kilogramme.

Originally garancine was worth 6 francs the kilogramme. For the last three years, the current price, without distinction whence it came, has been from 4 francs 50 centimes to 5 francs the kilogramme, with a discount of 6 per 100.

Up to the present time it has not been possible to class garancines according to their quality. Each manufacturer seeks to obtain the best products with regard to the quantity of coloring matter, and also with regard to the brightness of the tints; but the impurity of the first matters, and the neglect of trifling circumstances which the manufacture requires, often cause the products of the same manufactory to vary considerably. In trade, garancines are met with which afford four times more coloring matter than the madder which was employed to obtain them, whilst others give but two and a half.

This want of regularity is as much dependent on the degree of richness of the madder employed, as on the operations necessary in the production of the garancine; there is so much danger of burning the madder too much, or too little, that it is quite impossible to produce an identical garancine during a year. In great manufactories it is hardly possible to make from fifteen to twenty barrels which shall be nearly alike; for which purpose it is even necessary that the whole mass of roots required should be treated at one time. In general, good garancines possess three times as much richness of dye as the good madders.

The same mode of classification has not been adopted for the garancines as for the madders; the former are only distinguished by the names of the manufacturers.

The garancine, both of Rouen and Alsatia, is packed in casks of from 200 to 300 kilogrammes. That of Avignon is exported in casks, lined interiorly with blue paper, and with the jointures coated with tar.

During the last three years the consumption of garancine has been pretty regular; it may be calculated at from 1600 to 1800 barrels a year from Avignon, and from 400 to 600 barrels from Alsatia.

Before the introduction of this product into our manufactories, the yearly consumption at Rouen was from 3200 to 3500 barrels of Avignon madder, and about 1000 of Alsatian. For the last three years not more than about 2000 barrels of Avignon madder have been consumed, and 200 barrels from Alsatia. This diminution of nearly half the consumption of madder, is more than compensated by that of the garancine, and the Lizaris. The consumption of these last has, however, been almost nothing for five or six years; it may be valued at from 500 to 600 bales of every growth a year.

The following is the behavior of garancine towards solvents:—

Cold distilled water, . . .	After 24 hours of contact it has only assumed a pale yellowish color.
Distilled boiling water, . . .	Acquires a pale reddish yellow tint.
Cold calcareous water, . . .	After 24 hours it is less colored than with cold distilled water.
Boiling calcareous water, . .	A somewhat paler tint than with distilled boiling water.
Cold lime water, ...	After 24 hours the tint is paler than that with distilled boiling water, and than that with boiling calcareous water.
Water acidulated with sulphuric acid,	Takes, after some hours, a slightly greenish yellow tint.
Water acidul. with hydrochloric acid,	Id., a rather darker tint.
Cold dist'd water acid. with nitric acid,	Id., a rather darker tint, and the blackish gray powder becomes of a brownish red, resembling madder become brown by age.
Cold dist. water acid. with acetic acid,	Becomes faintly yellow.
Acetic acid of 1.0704 spec. grav., .	Acquires, after several hours, a beautiful reddish yellow color.
Caustic ammonia, ...	Becomes red immediately, and after 24 hours the liquor is strongly colored crimson red, so intense that it is no longer transparent in a great mass.
Water slightly alkalized by ammonia,	Immediately assumes a beautiful claret red color.

Caustic soda,	A dark reddish brown color.
Water charged with carbonate of soda,	Acquires quickly a bright reddish color of Burgundy wine.
Cold alum water,	Becomes almost immediately of a chrome red color.
Boiling alum water,	Acquires immediately a dark red color, and, upon cooling, deposits flakes of the same color, but paler.
Alcohol of spec. grav. 0.863,	Assumes rather quickly a slight reddish yellow color.
Hydrated ether,	Id., id.

Dyeing with garancine is effected in just the same manner as with madder. It is more advantageous, however, to raise the bath at once to 113° Fahrenheit, and then gradually to 167° or 176°. Garancine only yields its color to the tissue impregnated with the mordant at a boiling temperature. The water of the bath acquires no color even after ebullition, which always terminates the dyeing with garancine.

The mordants are the same as those which are employed for dyeing without madder.

For certain colors in which there is no violet, sumach is sometimes added to the bath to the amount of about a third of the garancine employed. At other times, for red grounds, for instance, the pieces are quercitroned before garancing, which imparts much brightness to the red, but renders the violet grey.

The proportion of garancine used in dyeing calico prints varies considerably, according to the intensity of the tints, and the quantity of color required by the pattern.

When the garancines are neuter, and the waters are calcareous, which is general in Normandy, they must be corrected by adding a variable proportion of sulphuric, acetic, or oxalic, acid to the bath. 1 centilitre of sulphuric acid of 1.028 to 9 litres of water, or 15 centigrammes of oxalic acid to a litre of water, are about the quantities employed. When sumach is added no acid is employed.

There are some garancines which are badly washed and acid, and to which it is, therefore, necessary to add chalk, or alkaline carbonates, in order to get rid of the too great excess of acid, which would be injurious; but chalk and alkalies are avoided as much as possible.

The great advantage of garancine is that it does not *charge* the white, and that the bleaching of the stuffs dyed with garancine is reduced to a mere nothing. When a very pure white is not required, it suffices merely to beat, and sufficiently clear, the pieces after the garancing. When a perfect white is required, the pieces are passed through bran for fifteen, or twenty, minutes. Hot water, or bran, are the only means used for clearing them. In this respect, therefore, garancine possesses a great advantage over madder which covers all the whites, and which renders it necessary to use soap, and to clear them more, or less, after the process of dyeing.

The tints obtained with garancine are generally more brilliant and

lively than those with madder. The *red* is vivid, of a carmine color of extraordinary purity, whilst the madder red placed by its side is always somewhat yellow, or of a fawn color, and dull, but, on the other hand, fuller. The *puces* and *garnets* made with garancine are much more velvety than those dyed with madder. The *violets* are not so pale, and delicate, and grey as with the latter. All the tints are weaker, and cannot so well bear soaping; they also require great care in the clearing, and resist less the action of the atmosphere and of the sun.

All the garancines, however, do not afford tints of equal richness and brilliancy. Some kinds produce a beautiful red, but a bad violet color; other kinds afford a magnificent puce, or violet, while the red is dull brown.

Garancine was first employed in the calico print works of Normandy. The Alsatian works refused to use this product for a long time; they only began to employ it about two years ago, in imitation of the calico printers of Rouen.

M. Leonard Schwartz, of Mulhausen, has recently sent into commerce, garancine prepared from the residue of madder which has been already used for dyeing. This matter, which he very improperly calls *garanceux*, is of much less value than the good Avignon garancine; $3\frac{1}{2}$, and even 4 parts, are scarcely equal to 1 part of the latter. It costs 2 francs 25 centimes the kilogramme.

B. The *Colorine* of commerce is the residue from the distillation of the alcoholic liquid obtained in the treatment of the *charbon sulphurique* with spirits of wine. The residue, which consists of *alizarine*, still impurified with a little fatty matter, is in the form of an extract when withdrawn from the retort. It is diluted with a little water, and pressed, in order to separate the fatty matter from it as much as possible. When dry it is reduced to powder. This is Robiquet and Colin's* *alcoholic extract of charbon sulphurique*, which MM. Ligier and Thomas, of Avignon, brought into the market in 1836, at 75 francs the kilogramme.

This product is in the form of a very fine powder of a yellow ochre color, without any decided smell, or taste; moistened, it stains the fingers strongly of a yellow color, but it hardly colors saliva. It presents all the chemical characters which Robiquet and Colin assigned to their alizarine.

The expectations which had been entertained by these skilful chemists, as early as 1827, as to the possibility of using alizarine for obtaining colors of application, were realized in 1837, by M. Pariset, of Rouen, who was then chemist in the works of MM. Feer, Dolffus & Company, of Dieppdalle, and formerly pupil of M. Chevreul; and simultaneously in 1838, by M. Gastard, chemist to M. Stackler, and M. Daniel Fauquet-Delarve, of the print works at Deville. Colorine dissolved in ammonia, and the liquor being thickened with gum, affords, in fact, when printed on calicoes with aluminous mordants, and exposed to steam, red and rose colors, which are, by no means,

* See MM. Robiquet and Colin's Memoir, (Bulletin de la Société Industrielle of Mulhausen, i. pp. 177, 178 and 181.)

inferior to those obtained with madder dyes. A patent for fifteen years was taken out on the 24th of November, 1837, by M. Stackler, for the carrying out the processes of M. Gastard; but the high price of the colorine of MM. Lagier and Thomas, prevented their adoption in the print works. The same was the case with regard to the processes of M. Daniel Fauquet, who obtained in large quantities more intense and richer reds than those of M. Gastard. M. Fauquet's processes possessed another advantage, in so far as he was able to cause his red to *re-enter (rentrer)* upon black grounds dyed with logwood and other dyes, and as this red did not require so many clearings as that of M. Gastard, to obtain vividness and brilliancy. M. Fauquet manufactured a large number of prints with applied red and rose colors, both in England and Scotland, but the enormous price of the primitive matter prevented his continuing. The Society of Emulation, of Rouen, on my report, decreed medals of encouragement to MM. Gastard and Fauquet, in 1839, for being the first to convert an experiment of the laboratory into an operation of the arts, and showing, in an indisputable manner, the justice of MM. Robiquet and Colin's presuppositions, viz., that it is possible, and even advantageous, to manufacture on a grand scale solid colors direct from the madder.

In 1840, M. Grelley and I undertook to investigate carefully the possibility of the practical application of the pure alizarine of Robiquet, a problem of the greatest consequence, since the *Société Industrielle*, of Mulhausen, proposed, in 1834, a premium of 19,900 francs, to be raised by subscription amongst the principal dyers and calico printers of France, for the *discovery of a red of application from madder*, the price of a pot of the color (containing two litres) not to exceed 10 francs.* This premium, which was continued until 1839, was never gained, and has been withdrawn. These facts show the great difficulty of the question. MM. Grelley and I have at last been able to solve it, by obtaining colorine at a price which allows of its being generally employed in producing red and rose colors of a good tint. We have described our processes in two *sealed packets*, deposited in the *Archives de l' Académie des Sciences*, dated 24th June, 1841. We have since brought our processes of extraction to greater perfection. Our product is of as good a tint as the best reds obtained in the ordinary method of dyeing; it bears all the customary clearings, and since it is far more brilliant even in its natural state, it more readily yields to the action of the clearings than the ordinary madder-reds. Used in very small quantities, it resists the strongest clearings that are employed for Turkey red, which generally requires an excess of coloring matter. This product may be used with the greatest facility. It is mixed with weak ammonia, and left in it to swell; it is then thickened with gum water, or with gum in powder, and applied to the tissue. The operations it requires after its application, only consisting in a simple steaming and rinsing with pure water, it may be printed, in every case, with all the other ordinary steam colors, provided it is not intended to be cleared. The prepar-

* Bulletin de la Société de Mulhausen, vii, p. 394.

ations preliminary to its application allow of its being applied to black grounds, or others obtained with matters of weak tint. It can be used of different degrees of strength on the same stuffs, and it it is thus possible to obtain tints from a pale red to the very darkest red.

We have applied it on black and white grounds, which, up to the present time, were injured in the ordinary operations of dyeing. We have also applied it with catechu, when the clearing required was merely a simple soaping. Lond. Chem. Gaz.

To be Continued.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Remarks on Warming Dwellings with Furnaces. *By* Franklin Peale.

The warming of houses, in our variable climate, is of such importance to our domestic comfort, as to demand careful consideration and attention, not only with regard to the primary object of maintaining an equal and sufficiently elevated degree of temperature, but also to health and economy; health and comfort may be considered synonymous, and the greatest amount of the two procured at the least expense, is the object towards which our endeavors are directed.

The subject is naturally divided into three branches:—

The first is of primary importance, and almost self evident—the advantage which is derived from *warming* large quantities of air, instead of *heating* small quantities, as is too frequently the case. By warming air in abundance, and conducting it into the apartments, an equal and summer-like temperature may be maintained throughout; the parts of the rooms furthest from the supply receiving a liberal share; whereas, if the air is over heated, it ascends to the upper part of the rooms, whilst the lower portions remain cooler, the discomfort of this state of things being augmented by an influx of cold air under wash-boards, at window-sills, &c., a sufficient explanation of the cause of the oft repeated complaints of cold feet in rooms generally over heated by furnaces of faulty construction.

The second branch of our subject, and the next in importance, is the general circulation of the air of the house, the entries and stairways entering into, and forming a part, of the system.

Warm air in large quantities being conducted into the rooms, it should be allowed to flow out through the open doors, the often repeated order to "shut the door after you," being not only unnecessary, but "more honored in the breach than in the observance." The cooler air of the entries and stairways descends in slow currents to continue the circulation, and it is essential that this descending current should be *entirely unimpeded;* any passage less than an ordinary doorway would diminish the object in view.

In all houses properly constructed, the means of warming should be determined and provided for, before a single foundation stone is laid, otherwise if the warm air system is subsequently adopted, which

is generally the case, there are numerous piers piercing the building from cellar to garret, mantels, grates, wide chimney places, &c., all of which are not only unnecessary, but actual incumbrances, reducing the size of the rooms, destroying their symmetry, and otherwise impairing their architectural proportions.

In houses planned with reference to warm air circulation, this important object can be readily and conveniently attained. In those of ordinary construction, a portion of the cellar is generally used for the location of the furnace chamber, (the word chamber being employed to designate the brick work which encloses the heating apparatus, consisting of furnace and drums, &c.) It will be necessary, in this case, to maintain the apartment, thus employed, neat and clean. It cannot be used as a receptacle for wood, vegetables, or other domestic stores: these matters must find another resting place, or the occupants of the house will have the annoyance of exhalations of a disagreeable character.

It is essential to exclude, carefully, the external atmosphere from a cellar employed with the object above stated, and of no small importance in any case, for otherwise, in winter, there is a temperature, it may be, of zero, within an inch and a half of the soles of our feet, which fact, if not the origin of the American custom of sitting with the feet elevated, is, at least, some excuse for it.

To accomplish the two objects, briefly stated above, that of warming an abundant supply of air, and procuring its general circulation, it will be necessary to construct the whole apparatus with this view: hence the necessity of a chamber of a size sufficient to contain a large amount of surface for the radiation of heat from horizontal drums, with a furnace and its appurtenances. This chamber must surround and enclose the furnace and drums to the level of the *grate*, but below that point it might be entirely dispensed with, so far as the warming of air is to be considered; in actual construction it should present as little obstruction as possible to the influx of air. Three sides entirely open to the foundation would be the most desirable form, with piers at the corners for its support, and one side entirely closed for certain other objects to be noticed hereafter. The temperature of the air being raised a single degree by its proximity to the furnace, its tendency to rise will effectually prevent any loss of heat; it has neither tendency nor ability to descend, and, therefore, need not be obstructed, or controlled, elsewhere, than at the registers by which it passes into the rooms which it is intended to warm.

From the chamber, flues lead the warm air into the various apartments, according to the system which these remarks are intended to illustrate. These flues should be of large area, clean, and smooth; the registers by which the admission is to be controlled, should rather exceed than fall short of the desired magnitude.

There are many situations in which it is desirable to convey the warm air horizontally to considerable distances, for the purpose of warming lateral apartments. If the chamber is constructed as above described, and the supply, or descending currents, as we have called them, be unimpeded, there is no difficulty, whatever, in so conveying it;

if, on the contrary, as is most frequently the case, the supply is limited to a few inches of area, either to the chamber, or the apartment in which it is placed, neither force nor persuasion will induce the air to take the unwonted course, and this obstinate conduct has been a sad puzzle to the uninitiated: indeed, there have been cases in which the projectors and builders have been astonished to find little or no heat making its way into rooms directly over the furnace, when the chamber was constructed with small apertures, and sometimes tortuous passages, for the admission of a minute quantity of air. How warm air was to come out of an arrangement, in the construction of which so much care had been bestowed for its exclusion, was indeed a mystery.

It is from this cause, principally, that so much prejudice has existed, and still continues to prevail, against the use of furnaces. The air, owing to the small area of the apertures for its admission, becomes over heated; the occupants of rooms, in order to get enough of heat, are obliged to make, or order, strong fires; particles of animal and vegetable matter floating in the air, coming in contact with red hot surfaces of iron, are carbonized, or decomposed, and hence arise effluvia, "vitiated air," head-aches, and antipathies to furnace heat, with numerous other objections, which have their origin, not in the system, but in the bad construction of the apparatus.

There are those among us who tell us that they love to look upon the cheerful blaze, and that they miss the sight of the fire: this is altogether a matter of association; if the parties can be made more comfortable without it, they will not miss it. He must be a chilly mortal, indeed, who would desire to gaze upon a bright blaze in June, or to toast his trotters over a glowing coal-heap in July.

Cases have occurred in which, to the no small surprize of the experimenter, a current was found to flow *into* the register, instead of the desired one *out* of it, like some refractory chimneys in which the draft is the wrong way, which perplexing circumstance remained a mystery, until a little careful examination showed that it was a natural result, in accordance with the laws which control this matter; in fact an inevitable consequence of the construction of the chamber, or of the apartment in which it was placed.

The explanation is as follows: Two separate air flues lead from the chamber of a furnace into apartments in the first, and second, or third, stories, of a house; we will suppose it to be the third story; there is, therefore, a column of heated air, in one of them, two stories high, with a strong draft upwards as a natural consequence; there is also a shorter column of heated air in the flue leading to the first story, which has also its tendency upwards, but as the furnace is so situated, or constructed, as not to supply a sufficient quantity for either of the flues, it follows, as a natural result, that the draft of the longer flue overcomes the draft of the shorter, and a current is established downwards in the shorter flue out of the lower apartment to supply the upper; in fact, in this case there is an inverted siphon of air flues, the longer limb of which overcomes the upward force of the shorter, and thus the lower apartment is "racked off." There is at present

an arrangement of apartments under our control, in which this effect can be produced at will.

The third branch of our subject has reference to cleanliness alone. The saving of domestic labor, and the comfort, however, which it is instrumental in aiding, render it of no small importance.

All house-keepers know the consequence of "raking out" a grate, in distributing ashes, in the form of a gray powder, in an even stratum, over the furniture and fixtures of an apartment. This annoyance can also be caused by furnaces; generally, however, in a modified degree. The remedy, is easy and effectual. The fuel and ash doors and grates should be placed in an apartment separated entirely by a partition, or wall, from that which contains the chamber, or supplies it with air. This separate apartment should contain the stock of fuel, and the passages to it should be carefully guarded by doors, with pullies and weights, so as to leave no excuse for their remaining open longer than may be necessary to give ingress, or egress, to the attendants.

The preceding remarks have reference to the construction and general principles of management. A few additional ones are demanded on the subject of the supply of air; and it is proper to add that they are the result of observation after long experience, as well as theoretical views, based upon a careful consideration of the subject.

If air is introduced from the external atmosphere, or, to use the common phraseology, from out of doors, care should be taken that the conductor by which it is conveyed should be very large, and that it should have its external termination in a pure locality. A narrow alley, with its gutter and garbage, cannot with propriety be considered a good source for the supply of wholesome air. A great inconvenience, however, must always exist in the variable temperature of the external atmosphere, causing difficulty in the management, besides additional expense, as more fuel must be consumed to meet this variable condition. Experience has shown that the occasional opening of external doors, and the numerous small openings in window frames and sashes, in entries and stairways, give an abundant change of air for all ordinary dwellings, and in all well constructed furnaces a complete and effectual ventilation of rooms can be had at will.

In churches and halls where large concourses are collected, two modes of management may be adopted; the first should, in the absence of the congregation, or audience, circulate the air of the building, by allowing it to descend through ordinary passages, such as stairways, if there are any, to the chamber of the furnace, or if there are none, then openings must be made through the floors, and, if need be, covered by gratings; this mode will be found not only more economical, but will warm more effectually the walls and fixtures, by which condensation of moisture upon them may be prevented; the second mode should be employed when a change of air is requisite, from the number of persons collected together, and is readily accomplished by opening a passage from the external atmosphere to the chamber of the furnace, or the apartment in which it is placed.

With regard to the use of water, little need be said. I am quite at

a loss to understand the part it plays in furnace warming. It is true that furnaces, especially those which overheat the air, exercise a drying influence upon furniture and wood work, because the capacity of air for moisture increases, within certain limits, as its temperature is raised. It is not necessary, however, to discuss the question, and it is left with the closing remark, that those who desire it, can, in any form of furnace, evaporate water, and send the vapor into their apartments to saturation if they prefer that condition.

In an economical point of view, it has generally been conceded that a stove of good construction is the cheapest means of warming an apartment; yet it can be demonstrated that the same stove, out of that apartment, will warm it more comfortably than when placed within it; and this apparent paradox is solved by placing it in a chamber constructed and supplied with air, upon the principles set forth and endeavored to be explained in the foregoing remarks; that is to say, if the same stove should be placed in a chamber, supplied abundantly with air, either from the external atmosphere, or by circulation through entries, an apartment above it will be more equally and agreeably warmed, with a reduced expenditure for fuel.

It is well known that there is a deposit of gray ashes, or dust, in the flues of furnaces, in which anthracite is the fuel employed; and that it is capable of exercising a corrosive action sometimes so rapidly as to destroy the iron pipes in which it rests in a very short time. It has also been observed that this corrosion does not take place whilst the furnace is kept in operation, except in those cases in which the iron pipe passes into the external atmosphere.

This destructive effect is caused by a deposit of the muriate and sulphate of ammonia, or other salts, which remain in a dry crystaline form as long as the fires are continued; but when these are no longer used, they seize upon the moisture of the air in damp weather, or from the damp location of the furnace, are dissolved and decompose the iron.

For further information on this subject reference may be had to the report from the sub-committee on corrosion of iron in steam boilers, when anthracite is employed as a fuel, in the Journal of the Franklin Institute, vol. iii, March, 1842.

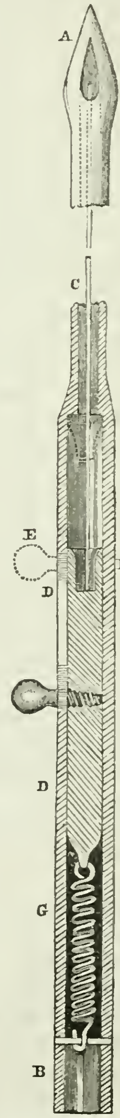
The remedy for this evil is so to construct the drums that one end of each shall pass through the wall of the chamber, and be furnished with a head, or cover, that can be removed, or to construct the whole series of drums in such manner as to allow their entire removal, both of which plans are followed in this city. In either case they should be carefully swept out and cleaned at the cessation of fire making for the season. White-washing the interior of the pipes with a thick wash of lime, has been found to be efficacious: drums thus treated have been in use six seasons, and are still in good condition.

It is not by any means necessary to consider these remarks as confined to warming by anthracite as the only fuel, or to dwellings in cities. They are even more applicable to country houses, and to wood, or other fuel. It is conceded that hard coal is the fuel which gives the largest amount of heat, with the least amount of labor for its atten-

dance; but it is also equally true that other fuel is largely and necessarily employed, to which the foregoing remarks are equally applicable, and, in some respects, even more so, than under the ordinary circumstances which have engaged our attention.

Philadelphia, April 18th, 1844.

Description of an Improved Wire Tube for Weaving Wide Velvet. *By* Mr. David Bond.



In weaving wide velvet, the wire on which the loops of the pile are formed, and afterwards cut, is conveyed into the shed of the warp by being placed in a tube; for the invention of which the Society rewarded Messrs. Hanchard, Cole, and Sodo, in 1839.

The defect in Mr. Hanchard's tube appears to be the liability of the wire sticking between the internal surface of the tube and the spring plug, which is used for pushing out part of the wire at the end of the tube, (A, in the accompanying section,) so that the wire may be held while the tube is withdrawn from the opening of the warp.

The injury thus occasioned to the wire in the original tube, besides the loss of time, renders Mr. Bond's improvement valuable to wide velvet weavers generally.

Mr. Bond makes the butt end of the tube B F, which contains the plug, larger than its main body A C, so that the wire may not be conducted to the edge of the plug, and thus become fixed between it and the inner surface of the tube. The spring G, draws back the slide as usual.

In the section A and B, are the two ends of the tube, the middle portion being omitted to save space. The wire is placed entirely within the tube through the opening at A, its lower end resting against the slide D. In this position the tube is ready to be passed across the warp, and when that is done the assistant pushes up the slide D, by its handle E, which will cause a sufficient length of the wire to protrude at the opening A, to enable the weaver to take hold of it; the tube is then withdrawn, leaving the wire in its place.

Trans. Soc. Arts, &c.

Professor Faraday's Invention for the Perfect Ventilation of Lamp Burners. By James Faraday.

In consequence of the injury sustained by the books in the library at the Athenæum Club, amounting almost to the entire destruction of the bindings, and the complaints of the members of the vitiated state of the air in the rooms, causing headache, oppressive breathing, and other unpleasant sensations, Professor Faraday's attention, as a member of the club, was drawn to the subject of ventilating lamp burners in houses, and he was induced to suggest the trial of various plans for effecting the removal of the products of combustion produced by sources of artificial light. All substances used for the purposes of illumination may be represented by oil and coal gas; although tallow and wax are also employed to a considerable extent, yet as until they are rendered fluid, like oil, they cannot be burnt. Now oil and gas both contain carbon and hydrogen, and it is by the combination of these elements with the oxygen of the air that the light is evolved. The carbon produces carbonic acid, which is deleterious in its nature, and oppressive in its action in closed apartments, and the hydrogen produces water. A pound of oil contains about 0.12 of a pound of hydrogen, 0.78 lb. of carbon, and 0.1 lb. of oxygen; when burnt it produces 1.06 lb. of water, and 2.86 lb. of carbonic acid; and the oxygen it takes from the atmosphere is equal to that contained in 13.27 cubic feet of air. A pound of London coal gas contains, on an average, 0.3 lb. of hydrogen, and 0.7 lb. of carbon; produces, when burnt, 2.7 lbs. of water, and 2.56 lbs. of carbonic acid gas; consumes 4.26 cubic feet of oxygen, equal to the quantity contained in 19.3 cubic feet of air. So a pint of oil when burnt produces $1\frac{1}{4}$ pint of water, and a pound of gas produces above $2\frac{1}{2}$ pints of water; the increase of weight being due to the absorption of oxygen from the atmosphere, 1 part of hydrogen taking 8, by weight, of oxygen, to form water. A London Argand gas lamp, in a close shop window, will produce, in four hours, $2\frac{1}{2}$ pints of water, to condense, or not, according to circumstances, upon the glass, or the goods, as it may happen. Also a pound of oil produces nearly 3 lbs. of carbonic acid, and a pound of gas $2\frac{1}{2}$ lbs. of carbonic acid. Now carbonic acid is a poison, an atmosphere containing even $\frac{1}{10}$th of it is soon fatal to animal life.

Mr. Leblanc has recently analyzed carefully the confined air of inhabited places, and concludes, as stated in his memoir, that the proportion of carbonic acid gas in such places may be regarded as measuring with sufficient exactness the insalubrity of the air; that in the proportion of 1 part to 100 of air, ventilation is indispensable for the prevention of injury to the health; that the proportion of carbonic acid gas had better not exceed a 500th part, though it may rise without inconvenience to a 200th part. If a lighted taper be applied to the top of a lamp chimney, it will be instantly extinguished, or a glass jar held over it will become immediately filled with air in which a light cannot burn. Also sulphurous and sulphuric acid are contained

in the water, which results from the combustion of coal gas, and are products injurious to metals and articles of furniture.

The object sought to be obtained in the ventilation of lamp burners, is the entire removal of all the noxious products of combustion, and with this view, at Professor Faraday's suggestion, the gas lights of the chandelier, in the library at the Athenæum, were ventilated by pipes dipping into the lamp glasses, and conjoining, at a short distance upwards, into one central pipe, which carried away all the burnt air from the room. In this first practical experiment many things were learned as to the mode of arranging the pipes, the disposal, when the pipes were very long, of the water produced, &c. &c.; but the objects sought for by the ventilation were at once and perfectly obtained.

Next arose the desire of modifying the system by removing the ascending flue from its place over the lamp, not from any deficiency in action, but for appearance sake only; and finding there was sufficient ascension power in the main part of the metal chimney to allow of a descending draught over the lamp, the tube, in place of going directly upwards, was made to turn short over the edge of the glass, to descend to the arm, or bracket, to pass along it, and then ascend at the central part of the chandelier, or against the wall, if applied to a single light. The gas light has its chimney, as usual, but the glass holder is so constructed as to sustain not merely the chimney, but an outer cylinder of glass, larger and taller than the first, and closed at the top by a plate of mica, or, still better, by two plates of mica, one resting on the top of the glass, and the other dropping a short way into it, and connected together with a metal screw and nut, which also keeps them a little apart from each other; thus forming a stopper which cannot be shaken off, but is easily lifted on and off by a small metal ring, or knob, at the top. The glass holder has an aperture in it connected by a mouth piece with a metal tube, which serves as a ventilating flue, and which, after passing horizontally to the centre of the chandelier, thence ascends to produce draught and carry off the burnt air. Now, with a lamp burning in the ordinary way, the products of combustion issue out as a torrent of ærial impurity from above; but if the above arrangement be applied on closing the top of the outer glass cylinder by the plate of mica, all the soot, water, carbonic acid, sulphurous and sulphuric acid, and a portion of the heat, are entirely carried away and discharged into a chimney, or the open air; and the air in rooms may thus be kept in the same wholesome condition, and as fit for the purposes of respiration as if artificial light were not being used.

A curious but important result of the enclosed lamp is the increase of light produced, amounting to from ten to twenty per cent., according to circumstances, the same quantity of gas being consumed as before. If the current of air through a lamp glass, when the gas is burning in the usual manner, be diminished, the flame rises in height, and the light is increased in amount, but is of a redder color; the combustion, in fact, is not so intense, because the excess of air is retarded, the particles of carbon which give the light are not so highly

ignited, but are more abundant, and are ignited for *a longer time*, thereby causing an increase of light. Ibid.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On the Fixation of Photographic Images by means of a Silver Bath.

Plunge the plate into a silver bath (cyanide of silver dissolved in cyanide of potassium) upon removing it from the mercury, let it stand for a few seconds, until the sensitive coat is dissolved, then establish the galvanic current. In 8 or 10 seconds the proof is fixed.

Its advantages are, first, it gives such great brilliancy to the lights, that the solarized parts become generally beautifully white; secondly, silver being a photogenic metal, the plates may be easily reprepared for use by rubbing with dry tripoli; thirdly, if you pour over a proof when taken from the mercury, or when fixed by silver, or chloride of gold, concentrated hyposulphite, and bring the liquid nearly to boiling, the proof takes little by little the most rich tints, passing successively from yellow to red, and from red to blue; the zinc pole determines these colors in the cold at the points near it. Proofs already fixed by chloride of gold give the richest colors.

Researches for the purpose of procuring a substance not containing Lead, to replace White Lead in the Arts.

The number of individuals affected with the lead disease, (colica pictonum) admitted during eight years, at the Hospice de la Charitè, was 1163. Of this number 406 were workmen employed in the manufacture of white lead, and 385 were painters. In the year 1841, the Department of the Seine furnished 302 sick, of which 69 were painters, and 233 manufacturers of white lead; of this number 12 died, and 1 became deranged. Of the 233 sick, the manufacture at Clichy furnished 161, and of the 12 dead, 7 were from this establishment, the only one yet which employs upon a large scale a particular method of manufacture.

None of the hopes founded upon peculiar methods for making white lead, have, as yet, been justified by experience upon a large scale. The dangers are, therefore, inherent in the employment of lead; and we believe that the only sure method, à priori, to preserve a class of workmen, of whom Paris alone contains near 8000, is to replace white lead by a combination not containing that metal. In consequence we give in our memoir a table of the preparation, and practical testing of a considerable number of white compositions.

Of this number two alone united the conditions of utility, economy, and salubrity. The first was a product which, although inoffensive, might in criminal hands, by means of very simple chemical reactions, resume its poisoning qualities; this consideration has induced us to renounce the result of a long labor. Pursuing our researches, we

have determined upon the oxide of antimony, (flowers of antimony.) It possesses the following qualities:—

It offers advantages in its employment, over white lead; by means of a method of manufacture selected by us, it is obtained directly from the native sulphuret of antimony. Its adoption will thus give a new vigor to the languid working of the mines of antimony which abound in France. Its price of production is less than the third of that of white lead of average quality.

It may be immediately ground with, or without, other manipulation. The workmen who are engaged in its manufacture, will be exempt from all danger, and it is altogether improbable that the painters who may employ it mixed with oil, will experience the least inconvenience from it.—*Comptes Rendus, Nov.* 20, 1843.

On the Desulphuration of Metals in General, applied to the preparation of Sulphuric Acid, and especially to that of Oxide of Antimony. By M. Rousseau.

The serious interest which is attached to the happy application which M. de Ruolz has made of the oxide of antimony, to replace the carbonate of lead, in all its uses in the arts, has induced me to present to the Academy, the results at which I have arrived in the desulphuration of the metals, and in particular the details of a process which M. de Ruolz has himself noticed as the complement of his beautiful idea, and to which he has given the preference as a means of rendering that idea practical. Up to this time the only method which metallurgy has employed for separating sulphur from different metals, consists in a more or less prolonged roasting; but in whatsoever manner this operation may be executed, the separation of the elements is never complete.

There is still another method of desulphuration, by which the sulphur and the metal are both, at the same time, oxidized, and the sulphuret converted into a sulphate. All chemists know, in fact, that it suffices to expose sulphuretted minerals, piled in heaps, to the atmospheric action, in order that a due combustion of the elements shall take place, and give to the sulphur and the metal all the oxygen necessary to the formation of a sulphate. The loss of time and other inconveniences which this method renders necessary, have, however, justly caused it to be proscribed in metallurgic operations. Still, by the observation of this simple and natural fact, and the reflection that if, to a temperature properly regulated, we unite the normal conditions, under the influence of which a chemical process takes place but slowly in nature, we may attain the same end in a few instants, I was led to examine what would be the joint action of air and water, upon the various sulphurets, at a temperature more or less elevated. The results were not only those of laboratory experiments, but were obtained upon masses of many thousand pounds weight. By this means all the sulphur is converted into sulphurous acid, and the metal remains in the state of an oxide, *entirely desulphuretted;* with this remarkable property, in the case of the sulphurets of iron and cop-

per, that the fragments, while they preserve their original form, increase materially in volume, and they crush under the slightest pressure. If we wish to collect and use the sulphurous acid gas for the manufacture of sulphuric acid, it is only necessary to establish a communication between the apparatus and the leaden chambers; then a proper ventilation may be established by means of the draft of chimneys, which it is easy to regulate. By these means it is possible to render useful either as ores of sulphur, or as oxides, on the one hand, the pyrites which abound so in certain localities, and upon the other, which is of much greater importance, the ores poor in metal, but rich in sulphur, such as certain sulphurets of copper, the too difficult roasting of which prevents their employment.

The preceding remarks will account for the preference which M. de Ruolz has given to this method, for obtaining the oxide of antimony from the raw sulphuret. In fact, the antimony obtained by this process is of a most beautiful white, and an impalpable powder: thus it may be employed immediately in painting, without the necessity of undergoing pulverization, or grinding. This substance, thus produced under the influence of the vapor of water, is reduced naturally to a degree of tenuity, which it is impossible to obtain by any other means.

Finally, this mode of preparation prevents the greater part of the chances of unhealthiness, if the emanations of the oxide of antimony should possess this quality, a supposition, however, which a long and well attested experience repels.—*Comptes Rendus, Nov.* 20, 1843.

Note upon the Influence of Jackets upon Steam Engines. By M. Combes.

A steam engine built by Farcot, was provided with an envelope to the cylinder, into which the steam was freely admitted from the boiler, and from which it passed as required into the cylinder. It having become necessary to repair this jacket, it was found that the expenditure of fuel was increased in the ratio of 6 to 10. A similar fact has also been observed in an engine of the same builder, erected near Sedan. A series of experiments was instituted by M. Combes, and conducted as follows:—

First, the machine was worked as usual, the steam being admitted to the jacket, and from the jacket to the cylinder; these experiments were continued for four days, the quantity of water pumped into the boiler being accurately measured, and the quantity of coal weighed; the amount of water condensed in the jacket was also ascertained, and every half hour the tension of the steam in the cylinder was measured by an indicator, and at the same time the pressure in the boiler, and in the condenser, were taken by gauges, and the number of strokes per minute of the piston counted.

Second, for three days the machine was worked by conducting the steam directly into the cylinder from the boiler, the jacket containing air only. The same observations as before were carefully made.

Third, for three days the steam was conducted directly to the cyl-

inder, but the jacket was kept in communication with the boiler, and was, consequently, filled with steam. The same observations were made as before.

The following are the results of the table:—

Exp'ts.	Duration.	Total Consumption.		Mean Pressures.			Consumpt'n per hour.		Water Evaporated by lb. of Coal.
		Coal.	Water.	Boiler.	Cylinder.	Conds'r.	Coal.	Wat'r.	
		lbs. avoir.	lbs. avoir.	Atmos.	Atmosp'e.	Atmosp'e.			
1	*43h. 15m.*	1482.7	8387.1	3.82	2.57	0.26	34.28	193.9	5.66
2	*33h. 30m.*	1982.12	11111.59	3.5	2.55	0.28	58.16	331.7	5.61
3	*32h. 30m.*	1469.5	7822.23	3.5	2.73	0.24	45.22	240.7	5.32

M. Combes attributes the increased quantity of fuel necessary when the jacket is not used, to the formation of water by condensation of the steam during its admission into the cylinder, and the consequent necessity of furnishing more steam to supply this loss by an additional evaporation from the boiler.—*Comptes Rendus, Nov.* 26, 1843.

Examination of Aqua Regia, and of a peculiar product to which it owes its principal properties. By M. A. Baudimont.

When a mixture is made of two parts by weight of nitric, and three parts of the hydrochloric acid of commerce, a red gas begins to be disengaged at about the temperature of 187° Fahrenheit. If this gas be passed into an U tube, which is externally in contact with pounded ice, the condensible matters which it brings with it are deposited. Experiment has shown that the first portions are mixed with hydrochloric acid, and that the last alone are sufficiently pure. This gas does not redden well dried litmus paper; but discolors it after some hours: it reddens it when moist. At 32° water dissolves .3928 of its weight, or 121 times its volume of it. This liquor is light red, and has a density of 1.1611. Enclosed in a hermetically sealed tube, it is not discolored by the long continued action of the solar rays; it possesses all the known properties of aqua regia. It may be liquified by passing it into narrow tubes plunged into a mixture of snow and salt. The liquid is dark red, but much less so than hypochlorous acid; it boils at 19° Fahrenheit. Its density at 46.6° Fahrenheit, is 1.3677. Its coefficient of dilatation measured above its boiling point in closed tubes increases very rapidly.

The density of the red gas, determined by two different methods, is 2.49. The liquid attacks all metals placed in contact with it; with the finely divided silver, obtained by the reduction of the chloride, it explodes and disappears instantly. It evaporates without attacking phosphorous.

Analysis shows its composition to be $AzO_3\ Cl_2$; that is, nitric acid, in which two atoms of oxygen are replaced by chlorine.

M. Baudimont proposes to call it chlorazotic (chloronitric) acid, although he admits that it is not in reality an acid, and does not combine with bases, but forms with them chlorides and nitrates.—*Comptes Rendus, Nov.* 20, 1843.

On the Pressure and Density of Steam, with a proposed new formula for the relation between them; applicable particularly to Engines working with high pressure Steam expansively. By WILLIAM POLE, Assoc. Inst. C.E.

The relations between the elasticity, temperature, and density of steam have long been interesting and important subjects of philosophical research.

The connexion of the two former, namely, pressure and temperature, with each other, has excited the greatest attention, numerous experiments having been undertaken to ascertain the values of them at all points of the scale, and many formulas proposed by English and foreign mathematicians, to express, approximately, the relation between them.

The pressure and temperature being known, the density, or, what answers the same purpose, the relative volume, compared with the water which has produced it, may be deduced by a combination of the laws of Boyle* and Gay Lussac;† and may be expressed algebraically in terms of the pressure and temperature combined; whence, by eliminating the latter, by means of the before mentioned formula, expressions can be arrived at which will connect at once the volume with the pressure.

But there are several difficulties in the way of this process, the equations which may be thus obtained, being too complicated for practical use; and, therefore, since it is important in calculations connected with steam and the steam engine, to find a tolerably accurate, and, at the same time, simple rule, which shall give the pressure and volume directly in terms of each other, the empirical method has been resorted to.

The paper enumerates three formulas given for this purpose by M. Navier, and M. de Pambour, explaining the peculiar cases to which they are applicable, and those in which they fail; and the author then proposes a fourth expression, which is intended to meet a case not provided for by either of the others, namely, for "condensing engines working with high pressure steam expansively;" such as the Cornish, and Woolf's double cylinder engine. The equation is,

$$P = \frac{24250}{V - 65},$$

$$\text{or reciprocally, } V = \frac{24250}{P} + 65.$$

* That "if the temperature remain constant, the density varies directly as the pressure"

† That "if the pressure remain constant, and the temperature change, the volume receives a certain definite amount of augmentation, for each degree of temperature added, or *vice versa.* This augmentation is =.00208 of the volume at the freezing point, for each degree of Fahr., or .00375 for each degree of Centigrade.

P, being the total pressure of the steam in pounds per square inch, and V, its relative volume, compared with that of its constituent water.

These formulas may be adopted without considerable error, throughout the range generally required in such engines, viz., from about 5 lbs. to 65 lbs. per square inch.

Two tables are then given, showing the pressures and volumes, as calculated for every 5 lbs. pressure in this scale; they show a comparison of the results of the four formulas with each other, and the respective amount of deviation from truth in each.

The great error is,

	lbs.	
By M. Navier's formula,	1.31	per square inch.
M. de Pambour's first ditto,	4.12	"
" " second ditto,	2.75	"
The new formula,	0.71	"

The mean error is,

By M. Navier's formula,	0.245	per square inch.
M. de Pambour's first ditto,	1.42	"
" " second ditto,	0.35	"
The new formula,	0.0062	"

The tables also show:—

1st. That the new formula is nearer the truth than either of the others taken separately, in three-fourths of the scale.

2nd. That it is nearer than all three combined, in half the scale.

3rd. That the greatest error of the new formula, with regard to the pressures, is only about half as great as that of the most correct of the other three.

4th. That the mean error is only one-fortieth of either of the others, and only equal to about one-tenth of an ounce per square inch.

5th. That the errors in the volumes are much less numerous and important with the new formula than with either of the others.

It is also added, that the new expression is simpler in algebraical form than the others; it is more easily calculated, the constants are easier to remember, and that no alteration of the constants in the other formulas will make them coincide so nearly with the truth as the new one does. Lond. Journ. Arts and Sciences.

On Fermentation. By Professor Brande.

The communication, to which this title was given, afforded a general view of that important class of chemical phenomena, of which fermentation is a single example, viz., decompositions and combinations, brought about by causes independent of chemical affinity. Having exhibited striking experiments illustrative of chemical affinity, Mr. Brande called attention to the fact that none of that interchange of the elements of the combining substances, which takes place under the influence of this force, occurs in *catalytic*, or *contact-action*. The phenomena, resulting from catalysis, are of two kinds: 1st, when

the substance producing the effects is altogether passive. The agency of platinum on a mixture of hydrogen and oxygen gases, is a striking instance of this sort of catalytic action. Mr. Brande reminded the members of a communication made by Mr. Faraday, some years since, on this subject. Mr. Faraday then drew attention to the fact, that a clean disk of platinum, immersed in an atmosphere of oxygen and hydrogen gases, mixed in the proportion, by weight, of 8 and 1, caused chemical union, with more, or less, of heat and explosion. Here the acting substance undergoes no change. But, 2nd, in organic catalysis, the substance producing the effects undergoes changes in itself, but does not, as in the case of ordinary chemical affinity, form union with the substance on which it acts. Thus in the case of rennet coagulating milk, or yeast, inducing fermentation in wort, each of these substances interchanges its particles with those of the liquid into which it is immersed, as happens when a plate of iron is plunged into a solution of copper, but the effect is obtained by the motion of the particles of the decomposing body among themselves, creating a corresponding movement in the body subjected to its influence. The decomposing body must be organic, contain nitrogen, and in a state of decay. This is the case with yeast when placed in a vessel of wort. It undergoes a change, connected according to some naturalists, with the growth of a microscope plant, and by this change splits the sugar of the wort into carbonic acid and alcohol. Having noticed the effects of this force of catalysis, Mr. Brande adverted to two theories respecting its nature—the doctrine that the particles of the decomposing body can communicate their motion to an indefinite mass of matter, and the doctrine that each particle of the decomposing body must be, in its turn, presented to every particle of the substances to be acted upon. After pointing out the difficulties inseparable from both these theories, Mr. Brande noticed, apparently with approbation, the simpler doctrine, that, in these cases, the combining force travels from particle to particle, as happens when a train of gunpowder, or an ordinary fire, is lighted. Mr. Brande concluded by adverting to an economical method of brewing, practiced, we believe, with much success in the family of Sir Thomas Marrable. In this method, yeast, as well as the expensive apparatus of coolers, is dispensed with. The wort, after the malt is strained off, is boiled with the hops, and together with the hops deposited in a barrel placed upright, arrangement being made for the escape of the carbonic acid, and for the barrel being completely closed as soon as the fermentation should terminate.—*Trans. Roy. Inst.* Lond. Athenæum.

The Hygro-Barometer. By Mr. Ross.

Mr. Ross explained his hygro-barometer, which has been so arranged that the height of the barometer column, and the depression of the dew point, may be registered from mere inspection, while these two elements are so combined, as to exhibit, in a popular manner, the real state of the weather. The instrument consists of a barometer

of the usual construction, and two thermometers, one of which is of the ordinary kind, and the other has its bulb kept constantly moist by a small skain of silk immersed in water, contained in the fountain bottle placed between the two thermometers. In the centre of the frame is an engraved table of figures, the object of which is to give the number showing the depression of the dew point below the existing temperature. It consists of two columns of figure, the one headed "temperature," and the other the "difference of temperature;" opposite to the figures of the first column, are horizontal columns of figures, which refer to the ordinary thermometer, and the large figures on the upper line of the second column, refer to the difference of the indications of the two thermometers. Above this table is an ivory sliding scale on the right hand, and a fixed scale on the left; the former, which refers to the barometer, is marked with divisions corresponding with tenths of inches, on the scale for measuring the height of the column of mercury on the ordinary barometer, and the latter refers to the hygrometer, and is marked with divisions corresponding with degrees of depression of the dew point, as given by the table; a brass index slides in and moves with the sliding barometric scale, and points to the fixed hygrometric scale, which has the usual words, "rain," "changeable," and "fine," engraved upon it. A blackened index slides in the fixed scales, and is merely to regulate the observation. The places of the various states of the weather, as "rain," "changeable," and "fine," on the hygrometric scale, have been fixed from a mean of three years' Meteorological Journal of the Royal Society, and were obtained in the following manner: when the height of the barometer was thirty inches, and the column of remarks indicated "changeable," the depression of the dew point was taken from its column; and the mean of all cases during the three years gave 6 for the mean depression of the dew point; opposite to six, therefore, "changeable" was accordingly placed. In like manner the place of "fine" was found to correspond with 12, opposite to which it is placed, and the place of "rain" is 0, or where there is no difference between the existing temperature and the dew point.—*Trans. Soc. Arts.*

Ibid.

On the Advantages of employing Large Specula, and Elevated Situations for Astronomical Observations. By C. P. Smith, Esq.

The author adverts to methods proposed by Mr. H. F. Talbot, for the multiplication of copies of specula by means of the electrotype, and for observing astronomical objects with a telescope absolutely fixed, by means of a revolving plane mirror, which methods he considers might, if carried out, produce great improvements in astronomy. Amongst the advantages of the latter method he enumerates the following, arising chiefly from the unlimited focal length which it would be possible to give to the mirror: first, the obviation of the necessity of an accurate parabolic shape for the reflector; secondly, the magnifying of the image without distortion, or color; thirdly, the small effect

which inaccuracies of the screw of the micrometer would produce, eye pieces of low power being employed; fourthly, the elimination of errors dependent on the contraction, or expansion, of the tubes of telescopes; and lastly, the advantage of having the eye in a fixed position. The author then enlarges on the advantages which would attend the use of such a fixed telescope if placed on the slope of a high mountain, with the object-mirror and the eye-piece fixed on piers, and separated by a considerable interval, the mirror being beneath. The Nilgherry hills in India, he instances as being favorable for the purpose, the climate being particularly well suited for astronomical observations. He then answers the obvious objection of the impossibility of reflecting objects from every part of the heavens to the speculum, by assuming that it would be most advantageous for astronomical science, that every observatory should confine itself to those classes of objects which its geographical position enables it most readily to command. He finally dwells upon the cheapness of the labor of computation in India, arising from the circumstances of the great number of Brahmin priests who are willing and competent to undertake the labor for a trifling remuneration.—*Trans. Astron. Soc.*

Ibid.

Cannabic Composition Ornaments.

At the last meeting of the Royal Institute of British Architects, and the Institution of Civil Engineers, several ornaments of this new material for decoration were exhibited. Any new material that may facilitate the introduction of ornaments into our dwellings, cannot be otherwise than acceptable, for, fortunately, a great demand exists in the present day for decorations.

The Cannabic composition is an Italian invention, which, although it has been some years in existence, has only lately been brought to such a degree of advancement, as to justify its introduction into this country. The material which is used in this composition is the common hemp, which possessing great tenacity, and equal pliability at the same time that it is procured in abundance, and at a moderate price, affords every facility for carrying out the invention. It admits of application to any internal architectural ornament, as ceilings, bosses, truss moulding, brackets, panels, capitals, pilasters, and mouldings of every kind, and in every style, as well as for external purposes. It has an exceedingly good surface, admitting of any kind of varnish, paint, or finish. For gilding it is most admirably adapted, likewise for painting, varnishing, burnishing, and bronzing, as may be seen, by specimens at Mr. Ponsonby's, the gilder and decorator in Piccadilly. It takes a beautiful bronze color, and by gilding acquires quite a metallic surface and high burnish. The advantage of these properties in decoration will be well appreciated by the architect, as giving new resources for carrying out his ideas. Neither are the consistency and durability of the material less observable, being at the same time hard and elastic. From these properties it is not liable to crack when put up in a room. It possesses a great degree of

sharpness and boldness, which, it is the intention of the patentees to increase by using a greater degree of mechanical power. It is such a light material that it admits of being put up in large masses on ceilings, and in other situations, in relief. With regard to external properties, it is not at all affected by wet, nor by the vicissitudes of the atmosphere, being water proof. In centre pieces for ceiling, door panels, and other compositions, as it admits of being executed in larger pieces, it is much less troublesome than the ordinary materials. The number of patterns for selection in the cannabic material at the present moment amounts to about four hundred, many of them quite new; but this number will speedily be increased, while the patentee will be most happy to afford every facility to architects who may wish to have patterns executed from their own designs.

The price, it is stated, ranges from about 10 to 20 per cent. below the prices of articles in common use, and it is on this ground that the patentees expect its extensive application. For decoration in the colonies and the East and West Indies, great difficulties at present exist, as most materials suffer rapid deterioration from the climate. The supply of a durable and cheap material, will, therefore, be the means of extending ornamental decorations in our extensive possessions: it is likewise well adapted for the decoration of steam vessels.

Civ. Eng. and Arch. Jour.

Preparation of a beautiful Green Color without Arsenic.

48 lbs. of sulphate of copper and 2 lbs. of bichromate of potash are dissolved in the requisite quantity of water, and 2 lbs. of carbonate of potash, (pearlash) and 1 lb. of chalk added to the clear solution. The precipitate is pressed, dried, and rubbed to a powder. This color is not so beautiful as the Schweinfurth green, but is peculiarly well adapted for painting dwelling rooms and work shops, there being no fear of any poisoning from arsenic.

By varying the proportions a number of different tints of this color may be obtained.—*Bittheilungen des Böhm. Gewerbevereins,* 1842 page 733.

Chemical Gazette.

Automaton Calculator.

Dr. Roth's automaton calculator was exhibited, and its action explained by Mr. Wertheimber. He gave a short review of the various attempts at constructing calculating machines, noticing the Roman Abacus, the calculating boxes of the Chinese and Russians; the several classes of instruments invented by Napier in 1617, by Perrault, and others, in 1720, and, subsequently, the slide rule invented by Michael Scheffelt, of Ulm, in 1699; the more important machines attempted by Pascal in 1640, by Moreland in 1673, by Gersten, and Leibnitz, which were submitted to the Royal Society of London, and the Académie des Sciences in Paris; he then mentioned the machine

of Mr. Babbage, upon which upwards of £20,000 had been expended before the project was abandoned, and the finished part, which formed tables of progression up to five figures, was consigned to the museum of King's College, London. Dr. Roth's machine appeared very simple, and its results, which were severally tested, were very accurate; it performed all the operations of arithmetic from simple addition, subtraction, multiplication, and division of numbers, or of pounds, shillings, and pence, to vulgar and decimal fractions, involution and evolution, and arithmetical and geometrical progression; it appeared particularly adapted for checking long calculations of quantities, for contractors, for merchant's counting house, or for government offices. The same principle had been adopted as counters for rotary, or reciprocating, machines, and they appeared from the compactness of their form, and their regularity of action, to be well adapted for the purpose.

Civ. Eng. & Arch. Journ.

Braithwaite's Process of Producing Imitations of Carving in Wood.

This invention was first produced in France, but has not been carried out to any great extent in that country.

In the carving of wood, as usually performed, two persons are employed, the one to cut out the intended subject in the rough, and the other to finish it. When a particular design is required to be executed by Mr. Braithwaite's process, a mould is made of cast-iron of the intended pattern, which is then heated to "cherry-red;" the heated mould being placed ready to receive the wood, viz., oak, chesnut, or other hard wood, to be acted on; the piece of wood is then rapidly, and with a power of from ten to thirty tons, according to the depth of the ornament, pressed into the mould by means of a lever press; and this is repeated until the full relief is obtained. The wood is then thrown into cold water, the charred surface being afterwards scraped, or brushed, off, after each application to the mould. After about 250 impressions have been taken off, the mould requires chasing; the whole number of impressions that may be taken from one mould is from 400 to 500.

Trans. Soc. Arts, &c.

Experiments on Coffee. By James J. Cunningham.

The object of the present communication has reference to some experiments on coffee, which, I think, possess some novelty, if they have no other merit. It is well known that this article, during the process of roasting, loses from 19 to 25 per cent. of its weight, this is principally water evaporated at the very high temperature it is exposed to. I speculated that if this moisture could be previously withdrawn, *without the application of heat*, a much shorter exposure to a high temperature would afterwards be required to complete the

process, and that an equivalent improvement in the quality might be looked for.

To test this I accurately weighed two packages of the same Jamaica coffee, each containing 8 ounces: one package, made up in paper, I inclosed in a jar with a very close cover, containing a quantity of fresh burned quick-lime; the second package I kept by me; I anticipated that the lime would attract the moisture from the inclosed air, and that the air would in its turn take the moisture from the coffee. After two months I opened the jar; the coffee did not appear shrunk, and was but very slightly altered in color, but on weighing it I found it reduced to $6\frac{7}{8}$ ozs., thus showing a loss of nearly 15 per cent. I separately roasted the two samples; the one I had kept by me still weighed 8 ozs.; it took the usual time, and when weighed was $6\frac{1}{2}$ ozs.; the second sample had scarcely been raised to the required temperature, when it suddenly swelled, and the process was complete in much less than one-third the usual time; when weighed it was $6\frac{5}{8}$ ozs. The following table will give a synopsis; No. 1, is the coffee that was treated with lime:—

No.	Weight before desiccation.	Weight after desiccation.	Weight when roasted.
1	8 ounces.	6.875 ounces.	6.625 ounces.
2	8 ...	......	6.500 ...

It will be observed that the sample No. 1, weighed more after roasting than No. 2. Part of this increase might have been caused by the latter being a little more highly roasted, but I am confident that this would not account for so great a difference in so small a quantity. The two samples were now ground, and prepared in the usual manner; the quality of No. 1, was much better than the other, being stronger, more aromatic, and finer in flavor.

Lond., Edin. & Dub. Phil. Mag.

BIBLIOGRAPHICAL NOTICE.

Observations on Vegetable and Animal Physiology. By WILLIAM L. WIGHT, M. D., Petersburg, Virginia: pp. 36, 8vo.

In the essay before us the author has attempted to explain many of the phenomena which take place in the growth and development of plants and animals, in doing which he calls into requisition the results of the latest researches of science, aided by observations and experiments made by himself. The interest taken in such subjects is at present very general and strong, and, we think, one of the best proofs of this is afforded by the rapid sale in the United States of perhaps more than 20,000 copies of Liebig's late essays upon vegeta-

ble and animal chemistry. From such investigations agriculture and medicine must be greatly advanced, as many of the phenomena of vegetation and the animal functions, both in health and disease, are deprived of the obscurity which has hitherto enveloped them. But Dr. Wight does not restrict his inquiries to the growth and nourishment of plants, the play of animal functions in a healthy condition, with the analogies and distinctive features of the vegetable and animal kingdom. He goes further, and applies the laws and facts of electro-chemistry to explain the morbid phenomena connected with pathology, or the derangements of healthy action. His views upon all the topics referred to are highly interesting to the general reader, and more especially so to numbers of his profession. They are recommended by their ingenuity and boldness, and certainly reflect great credit upon their intelligent author.

Lunar Occultations.

Lunar Occultations visible in Philadelphia during the month of June, 1844; computed by Mrs. Charlotte S. Downes, from the Elements published with the Occultation list of the United States Almanac.

The Immersions and Emersions are for Philadelphia, mean astronomical time. Im. for Immersion, Em. for Emersion. These abbreviations in *Italics* refer to those Immersions and Emersions which take place on the Moon's dark limb. N. App. for Near Approach.

The angles are for *inverted image*, or as seen in an astronomical telescope, and reckoned from the Moon's North point and from its Vertex around through East, South, West, to North and Vertex again. For direct vision add 180°.

JUNE, 1844.

Day.	H'r.	Min.	Star's name.			Mag.	From North.	From Vertex.
7	14	4	Im.	16	Piscium,	6	28°	78°
	14	57	*Em.*				280	328
11	17	27	N. App. 40		Arietis, ☽ N. 0′.1,	6		
15	8	3	N. App. κ		Cancri, ☽ N. 0′.7,	6		
19	7	37	*Im.*		Bessel,	9	124	73
	8	38	Em.				286	234
19	8	41	N. App.		Bessel, ☽ N, 1′.0,	9		
20	7	29	*Im.*		Bessel,	9	116	69
	8	35	Em.				299	250
20	8	30	*Im.*		Bessel,	8	116	65
	9	30	Em.				294	243
21	9	41	*Im.*		Bessel,	8	98	48
	10	37	Em.				309	259
21	9	55	*Im.*		Bessel,	8.9	75	25
	10	40	Em.				332	282
21	10	20	*Im.*		Bessel,	8.9	101	51
	11	14	Em.				304	254
21	10	30	*Im.*		Bessel,	9.10	119	69
	11	24	Em.				286	236
23	11	15	*Im.*	*q*	Virginis,	5.6	68	20
	11	59	Em.				331	281
27	8	7	Im.	*g*	Ophiuchi,	5	143	167
	9	11	*Em.*				248	260

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE

State of Pennsylvania

AND

AMERICAN REPERTORY.

JUNE, 1844.

Civil Engineering.

Foundations on Sand.

The subject of foundations on sand has latterly attracted a good deal of attention here, and particularly on account of Mr. Perring's discovery, that many of the buildings in Egypt were built on such foundations. "It seems that the stony surface of the desert had been made level by a layer of fine sand, and confined by a stone platform 14 feet 6 inches wide, and 2 feet 9 inches thick, which supported the external casing, and the pyramid (that of Dashhour) was built upon the sand, which is firm and solid." Other examples of the same kind were met with by Mr. Perring, and it seemed that the sand, when retained in its place, could be depended upon. We have, therefore, thought it would be interesting, while public attention is directed to the subject, to notice what has been done on this system in France. It seems to have been first adopted in 1822, by M. Devilliers, C. E., when employed on the canal of St. Martin, were he used it extensively. It is to be observed, however, that it is the only system employed in the Dutch Colony of Surinam, and was suggested long since by Captain Rosmy, but not applied.

We have no account of M. Devilliers' works, and the process seems to have remained in abeyance until 1830, when Captain Gauzence, of the French Engineers, employed it for the support of the portico of the Guard House of Mousserolles, at Bayonne. This plan is represented in fig. 1, where A, represents the front of the portico: B, the façade of the guard house; and C, the sand foundation.

The soil was a slippery, greasy clay, extending to a considerable depth, and it was at first proposed to lay down a platform of wood, as a basis. Capt. Gauzence's suggestion, however, having been adopted, the soil was dug out to about a yard below the substructure, and filled in with sand well rammed. On this were laid two courses of Ashlar masonry, and then a course of dressed stone, forming the surbase. Before finishing the columns, one of them was laden with ten tons of lead without any sensible effect being produced. The structure was finished in October, 1830, and no settlement has taken place since, though each column is computed to carry a weight of ten tons, and a wall of the same guard house, otherwise built, has settled a good deal.

Fig. 1.

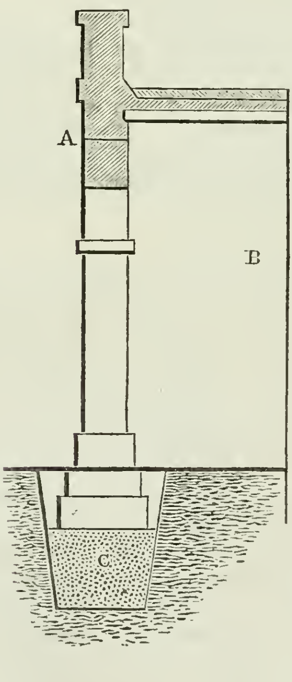
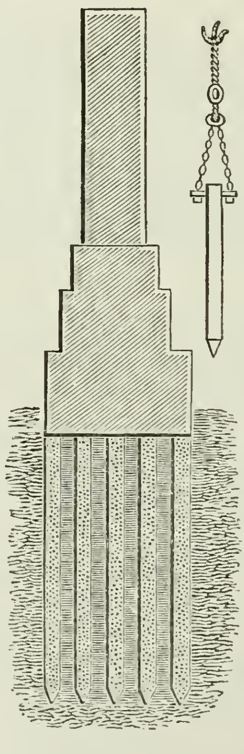


Fig. 2. Fig. 3.



The same plan has been successfully pursued in some of the fortifications of Bayonne, where buildings had to be placed on made ground.

In 1836, a sand foundation, about $2\frac{1}{2}$ feet thick, was employed with an equally satisfactory result, for the quay wall of a small harbor on the coast of Brittany.

For the construction of the artillery arsenal at Bayonne, another

plan has been adopted. The soil is of the same greasy kind before described, while it is quite impossible to use wooden piles, for not only is wood very dear in the neighborhood, but at high water a stratum of water penetrates the soil, which rapidly rots wooden piles, or platforms. Colonel Durbach, therefore, proposed to employ what have been termed piles of sand. The forge department is surrounded by square piers united by a wall, and in fig. 2, we have a section of one of the piers, the weight of which, and of the carpentry supported, is about 35 tons.

The foundation piles are so arranged that each bears only 2 tons. The process adopted was to drive into the ground an ordinary wooden pile about 7 inches square, and 6½ feet long. This was then drawn out, and the hole filled with sand. The surface was then levelled, the sand well rammed in, and the masonry raised upon it. To draw the wooden mould pile, an ordinary machine was used, to which a chain was attached in the manner shown in fig. 3.

In 1833, Colonel Durbach's plan, with some modification, was employed by M. Mery, C. E., in the canal of St. Martin, at Paris, for the construction of a lateral culvert, which passed through ground of bad quality, in which a quantity of water was infiltrated. Instead of sand, which would have been washed away, sand mortar was used, made by mixing one seventh of hydraulic lime with six sevenths of sand, which soon consolidated.

With regard to the sand to be employed, it is recommended that it should be moderately fine, of equal grain, and not earthy. It must be moulded and rammed in layers of about 8 or 9 inches thick, which is an important point.

The theory of this process is not known, but it is supposed that the pressure is equally distributed on the sides as well as on the base. Some curious circumstances as to the pressure of sand are to be observed in connexion with blasting, where it is found to produce the most efficient tamping.

Civ. Eng. & Arch. Journ.

Great Western Steam-Ship Company.

A general meeting of the proprietors of the Great Western Steam-Ship Company was held on Thursday, March 14, at Bristol. The following is an abstract of the Directors' Report:—

"The receipts by the Great Western, for 1843, have amounted to £33,406 0*s.* 4*d.*, and the expenditure has been only £25,573 4*s.* 3*d.*; the receipts for 1842, having been only £30,830 8*s.* 2*d.*, while the expenditure was £28,615 7*s.* 1*d.* To the improved state of things in the United States much of this is to be attributed, a good deal to the close attention to expenditure; but your directors believe still more to the circumstance of Liverpool having been altogether the rendezvous for your business on this side of the Atlantic."

The report then states that the Great Western's last winter voyage to New York, by way of Madeira, had been rendered unprofitable,

the carelessness of the New York pilot having allowed her to touch the ground, in consequence of which that vessel had to be surveyed and repaired at her majesty's dockyard, at Pater, at an outlay of £606, in addition to which it was calculated that a loss of £1500, in passengers, had been sustained by the unavoidable delay, and change in the times of sailing. She had been subsequently docked in Bristol, and "thoroughly examined," when, according to the directors, it was "impossible to over rate her condition." The pilot at New York has been suspended on the representation of the company, and the underwriters at Lloyd's had signally marked their sense of Captain Hosken's merit in bringing home the vessel. "The Great Western has run nearly 240,000 miles, at a higher average speed than had been attained by any other sea-going steamer—10⅛ miles per hour." In September last, the company's engineer reported that the boilers, which had done duty for six years, might, at an outlay of £1000, be made to last for one, or, at most, two seasons longer. Under these circumstances the directors thought it better to have new boilers, the estimate for which is £3000, which are now being rapidly put up on board, are known by the name of tubular, and require only half the space of the old ones, by which the stowage of the ship, for either coals, or cargo, has been increased to the extent of upwards of 200 tons. She is also to have new paddle-wheels, which are nearly finished, and in progress of fitting in place. The directors observe:—

"Mr. Ashton, the well known ship-broker and auctioneer, was employed to effect a sale of your works, either by private contract, or by auction, and your directors regret to announce ineffectually. The time is now fast approaching when they will be closed, unless parties come forward to take them off your hands. Situated as your premises are, with water-side frontage, ample space for building, a graving dock of the first class, and in other respects a more convenient engineering and ship building establishment than any in the kingdom, your directors long since expected that they should be able to communicate to you that the mechanics and other able hands, who, before their establishment, were, many of them, strangers to Bristol, would not have had occasion to turn their backs upon the city; they still trust these hopes may be realized, and that the time will not arrive when it will be advisable to sell the tools and the materials piece-meal. Your directors have, on more than one occasion, suggested to you the good effects to be anticipated from your arming them with authority to tender for government vessels, or otherwise to work for the public. The opportunities have been numerous, and if they had been authorized to have accepted some of them, Bristol, they think, would by this time have become a steam-ship building port of the first class, and your establishment, in all probability, in a flourishing condition, instead of being, as it has a prospect of being, on your hands, subject to an outlay for rent, taxes, and maintenance, of not less than £400 per annum."

Prince Albert's visit, and the undocking of the Great Britain, are then briefly alluded to, it being stated that "the whole of the expenses of that auspicious occasion were defrayed from the fund arising from

the sale of tickets, or from visitors to the works." The report then goes on to state that, "for the purpose of opening the bank fronting the dock in the most inexpensive way," the Great Western Steam-Ship Company had obtained the permission of the Dock Company to lower the water in the float six feet. Circumstances, however, had rendered it necessary to lower the water considerably below the six feet asked for;" and on the 13th of December, nearly six months after the event, the Dock Company made a claim of £312 17*s.* 10*d.* for damage done to the ship Augusta, in consequence of the lowering of the water. The payment of this sum had been resisted, and the "not acceding to this demand, the directors have reason to fear, has operated injuriously upon the consent of the dock board to the passage of the Great Britain through the locks." The report then goes on to speak of the Great Britain.

"The size of your ship Great Britain, was not finally settled until the year 1839. At your annual meeting, in 1840, her dimensions were made known to you, and a model was laid before you. Before, however, the final settlement of her power and capacity, deputations from the public bodies had been, for months, sitting in committee, with the view of arriving at some conclusive recommendation to the city, by and through which it was anticipated that the trade of the port would be relieved by arrangements with the Dock Company, and its locks thrown open for the ingress and egress of a larger class of steam vessels than those which are of necessity, your directors believe, confined to Bristol only; and one of the resolutions which were reported to your town council on that occasion, as the result of the indefatigable exertions of the gentlemen composing that committee was, 'that it is essential to the trade of the port that the entrance to the floating harbor should be made wider'—at the same time your consulting engineer, Mr. Brunel, was employed by the council to survey the harbor and rivers, and did, after completing the same, hand in estimates for widening the old locks, or forming a new one.

The Great Britain's beam and form were a good deal affected by the width of the locks, which were supposed to be 45 feet nearly all the way up and down; on measuring, however, your engineers have since found they are much narrower, even at the average high water mark. The great buoyancy of iron ships is such, that to gain a draft of water, which then, as well as in the present state of knowledge of ship building, was supposed to be necessary to give stability, and the other qualities necessary for a sea-going steamer, the usual form of steam-ship building had to be abandoned, and the breadth towards the bottom considerably contracted; capacity, consequently, had to be looked for above rather than below the water line. This and other considerable advantages led to the adoption of the form in which the Great Britain is built, her widest part being far above the line of flotation; and they have great pleasure in stating that she has been visited by most of the eminent ship builders and engineers of this and the neighboring kingdoms, and her construction and form not merely highly approved of, but greatly admired. About the middle of the year 1841, your engineers reported to your directors, that a great

saving would follow putting the boilers on board in dock, and, at the same time, they were informed that it was not likely the ship would be allowed to occupy nearly a whole side of Cumberland basin for so long a time, as it was then discovered would be necessary to complete her equipment; and in 1842, your directors reported to you that the most economical way of getting the machinery on board would be through an aperture in her side while in the dock, by which the necessity of floating her would be avoided. Your directors were fully aware that by this decision they would have to seek the consent of the dock directors for a temporary removal of two or three of the upper courses of stones of the lock, and the unshipping of the gates of either one, or both, sides for a few days, which they were assured by your consulting engineer, who acted in the same capacity for the dock directors, would be a matter comparatively inexpensive in execution, without risk, easy of accomplishment, and in no way likely to inconvenience the trade of the port."

The report then proceeds to detail the unsuccessful negotiations with the Dock Company, respecting the facilities afforded for getting the Great Britain into and out of Cumberland basin; the directors observing, that they had not anticipated such a termination to the negotiations, more especially as "the actual dues on the Great Western, received by the Dock Company, have amounted to £2,500, while those upon her several cargoes, which the directors have no means of computing, must have been considerable." The consequence of this want of agreement between the two companies, is that instead of getting the Great Britain into Cumberland basin on the 21st inst., and out of it for Kingroad on the 4th of April, it is "the painful duty" of the directors to inform the Steam-Ship Company, that they anticipate so much delay from the plan which they are now driven to adopt, that they think it will be impossible to keep the advertised dates of the sailings of the Great Britain. The report then goes on to state:—

"The expenses for experiments on the *Archimedes* have been reported to you. Your directors regret that she was taken away before they were completed. A three-armed screw made for her at your works, was tried by Mr. Guppy, on the French man-of-war Napoleon, a vessel of more than double the power of the Archimedes, and with it a high speed was attained; and your directors believe with a screw of proper size on a similar plan, she is, at this moment, admitted to be the fastest man-of-war afloat. Your consulting engineer's services have been engaged by the Lords of the Admiralty to report upon screws, and for this purpose her majesty's ship Rattler, of 800 tons, and 200 horse-power, has been placed at his disposal. Her experiments have been frequently attended by one, or other, of your officials, as were also experiments, three years ago, upon her majesty's ship Polyphemus, a sister vessel, with paddle-wheels. In her a speed of nine knots was attained in Southampton water. The late results of the Rattler have been nine and a half, better than half a knot over the speed of the Polythemus, as well as of another sister vessel of the same power, and in the same place with paddle-wheels—her majesty's

ship Prometheus in the Thames. Your directors have been induced to dwell upon this subject, not merely in consequence of its importance, but because of garbled statements of speeches in the House upon the navy estimates, or of assertions not founded on the real facts of the case, having led many of the proprietors to seek for information at your office. Your consulting engineer, and Mr. Smith, the patentee, are acting with the most perfect understanding, and the speed of the Rattler has been improved with every alteration of the screw, the principle, your directors believe, remaining the same. Your directors greatly regret that it became necessary to put the Great Britain's screw in hand before the experiments in the Rattler were concluded. They will not quit this subject without reminding you that it has never been asserted that a higher rate of speed is expected to be attained in perfectly smooth water, with a screw than with paddles; but that it has numerous advantages over the paddle for long voyages on the ocean, and that the averages are likely to be better; and as certain authorities have asked what the speed of the Rattler is, or what about 11 statute miles per hour is to 15 or 16, or even more, which is reported to have been attained by fast boats on the Thames, the Hudson, and other rivers; you are to recollect that the power in her majesty's ships is seldom more than one horse to four tons, while in the fast river boats it is about as one to two tons, or even less, and that few, if any of them, would be safe at sea in bad weather, from the slightness of build, and disproportion of weights. The Elberfelt, recently caught crossing the channel, is a case in point. If your directors are rightly informed, she was built for the Elbe, of iron one-eighth of an inch thick, and did not draw two feet of water. The accounts of the company are appended to the report, and after reserving the sum of £430 13*s.* for the reduction of the preliminary expenses of the company, and £767 in reduction of stock, a dividend has been declared of £2 10*s.* per share, or 7½ per cent. on the original cost, or 9¼ per cent. on the reduced cost of the Great Western, which will become payable on the 15th inst., free of income tax, leaving a balance of £1,511 9*s.* 1*d.* to be carried to the reserved fund, making the amount, with interest, £13,139 3*s.* 4*d.* in reduction of the original cost of the Great Western.

Subjoined to the report is a statement of accounts, in which the following is given as the cost of the Great Britain.

Hull, engines, and boilers,	£66,790	3	10
Fittings,	8,908	13	8
Masts, rigging, boats, pumps, cables, and stores,	2,110	9	4
General expenditure, including screw experiments,	19,344	17	6
	£97,154	4	4

Ibid.

The Screw and Paddle-Wheel Trial.

A government trial of the screw propeller took place on the 3rd of March, with her majesty's steamer Rattler, at the measured distance in Long Reach, in order to determine, as correctly as possible, her rate of going, as compared with that of her sister ship Prometheus, which had been ascertained by the government authorities the day before, by a similar trial. The Rattler having been built for the purpose of testing the merits of the screw propeller with those of the paddle-wheels, is constructed, as nearly as possible, upon the lines and models as the Prometheus; they have both the same amount of engine power, viz., 200 horses; both vessels were laden to the same draught of water, viz., 11 feet 3 inches; the steam pressure in both cases was regulated alike, in fact, every thing that could be conveniently done to render the trial a fair one was duly attended to. Under these circumstances more than ordinary interest was excited amongst the naval and engineering officers connected with the Woolwich Dockyard establishment, by whom the results of the various trials of both vessels were most minutely noted, and, in the end, summed up, contrary to the general expectation, in favor of the Rattler, to the extent of nearly half a knot per hour, their relative speed being as follows:—Prometheus, 8.757 knots; Rattler, 9.240 knots, or within a fraction of 10¾ statute miles per hour. The Prometheus is one of the third class war steamers recently introduced into her majesty's navy by the present surveyor, Sir William Symonds, and is, we are informed, under orders to sail almost immediately for the Mediterranean.

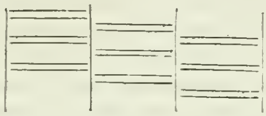
Having given the particulars of the government trial of the screw propeller, and the paddle-wheel, with her majesty's steam-ships the Rattler and Prometheus, the former vessel was fitted with the screw, and the latter the paddle-wheel; as the experiment is one of importance, we have taken the trouble to obtain the proportions of the Rattler. We understand that as far as the build of the vessel, the porportions of the Promethens are nearly the same.

Dimensions of H. M. S. Rattler.	Feet.	Inches.
Length, extreme,	195	0
Ditto, on decks,	176	6
Ditto, on keel for tonnage,	157	9½
Breadth, extreme,	32	8½
Ditto, moulded,	31	10
Depth of hold,	18	7½
Burthen in tons $888\frac{34}{94}$,		
Draught of water, (mean)	11	3
Area of midship section at 11 ft. 3 ins.	280	
Engines—Maudslay's 4 cylinders, aggregate power 200 horses:—		
Diameter of cylinders,	00	40

Dimensions of H. M. S. Rattler.	Feet.	Inches.
Length of stroke,	4	0
Diameter of screw,	9	0
Pitch of ditto,	11	0
Length originally,	5	6
Ditto as reduced on the occasion of the trial,	3	0

Number of treads two.

The gearing at present consists of two motions, which gives a velocity of four to one of the engine. The first motion of two to one consists of a large spur wheel and pinion, the cogs of which are divided into three parts, thus—



those of the larger wheel being made of hard wood, and the smaller one of iron; this sub-division of the wheels prevents that very disagreeable rattling which is so much complained of.

The second motion consists of a large and small drum, with their surfaces divided into seven convex parts, thus—

upon which seven leather-straps, of five inches in width, are kept tight by a suitable pulley, or drum, for that purpose. The drum and straps have merely been put in to try their efficiency, and to allow the multiple to be diminished, or increased, as circumstances may require. It is intended, when the experiments have been completed, to remove the drums and straps, which will be replaced by a single wheel and pinion of requisite proportions.

It is estimated that from 18 to 20 horse-power is absorbed in transmitting the power of the engine through the medium of straps at so great a velocity as is required to drive the screw.

Diameter of Gearing.	Feet.	Inches.
Diameter of spur wheel,	11	2
Width,	2	6
Pitch,	0	5
Diameter of pinion,	4	4
Ditto, large drum,	10	6
Ditto, of small drum,	6	9

The boilers are upon the ordinary flue principle.

The boilers of the Prometheus are upon the new tubular principle, the diameter of her two cylinders $52\frac{1}{2}$ inches, length of stroke 4 feet 6 inches. Ibid.

Ball and Socket Leveling Instrument.

A ball and socket leveling instrument, constructed by Mr. Adie,

for Thomas Stevenson, Esq., C. E., and also an improved portable leveling instrument and rod, were exhibited. Communicated by David Stevenson, Esq., F.R.S.S.A., C. E. In this ball and socket spirit level, designed by Mr. Thomas Stevenson, C. E., the first peculiarity is the substitution of a small circular level fixed upon the upper side of the tube, for facilitating the setting of the instrument, instead of the delicate cross level at present in use. But the principal advantage of Mr. T. Stevenson's improvement consists in the combination of the ball and socket motion for the first setting, previous to the application of the parallel plate screws for the final adjustment. The ball and socket was long in use, but for about half a century it has been almost entirely discarded, and the parallel plate screws substituted. In the level exhibited to the Society, the ball and socket has been restored, and the parallel plate screws retained, so that by this union the advantages peculiar to both systems have been attained. The person using this instrument is, in consequence, rendered quite independent of the rugged nature of the ground on which it is set, or the inclination of the telescope to the horizon, as by looking first at the small circular level, he can in an instant bring it nearly right by means of the ball and socket, after which a slight touch of the parallel plate screws perfects the adjustment. In this way the observer can set his instrument with exactly the same rapidity and ease on a steep slope as on level ground, and is enabled to proceed with equal facility at such rugged stations as would, in the instrument now in common use, altogether exceed the range of the parallel plate screws. The practical surveyor will see the great saving of time and trouble resulting from the use of Mr. Stevenson's instrument.

Mr. David Stevenson also showed a portable level and rod, constructed to his directions, by Mr. Adie. With nearly the same accuracy as the large levels, this instrument possesses the advantage of much greater portability. It combines a telescope 10 inches long, a compass, and a level, and is packed in a flat leathern case measuring about 6 inches by 2¾ inches, rendering it very convenient for perambulatory surveying, for which it was made. It rests on a tripod, which is also very portable. The leveling rod accompanying this instrument, when closed, forms a round staff 3 feet 6 inches long, which is cut longitudinally through the centre. The two parts are hinged at one extremity, and when the rod is to be used they are opened and fixed by a spring. The scale is marked on the flat side, and when the staff is closed the figures are protected from injury.—*Trans. Roy. Scot. Soc. Arts.* Ibid.

Wrought Iron Lattice Bridge erected across the line of the Dublin and Drogheda Railway.

At the meeting of the Institution of Civil Engineers of the 9th ult., Mr. G. Hemans read a description of this bridge. In construction, it is similar to the wooden lattice bridges of America, only substituting wrought-iron for timber, and is situated about three miles from Dub-

lin, over an excavation of 36 feet in depth; its span is 84 feet in the clear, and the two lattice beams are set parallel to each other, resting at either end on plain stone abutments built in the slope. These beams are 10 feet in depth, and are formed by a series of flat iron bars $2\frac{1}{2}$ inches wide by $\frac{3}{8}$ of an inch thick, crossing one another at an angle of 45°; at 5 feet 6 inches above the bottom edge transverse bearers of angle iron are fixed, similar to those now used for supporting the decks of iron steam vessels, and upon these the planking for the roadway is fastened. The account of the mode of construction, and of the raising and fixing the lattice beams, by Messrs. Perry, of Dublin, the contractors, was given in detail; and the author stated that although it was expected that considerable deflection would occur, which was provided for by forming the beams with a curve of 12 inches in the centre, they did not sink at all, even when heavy weights passed over them. The total cost of the structure, including the masonry of the abutments, was £510.

Glasgow Mech. & Eng. Mag.

The Menai Bridge.

The following particulars relative to the Menai bridge, may prove acceptable to many of our readers. The distance between the piers is 551 ft. The elevation of the roadway above high water mark 102 ft. The width of the roadway is 28 ft., viz., the two carriage-ways 12 feet each, and the footway 4 ft. The weight of the chains between the piers, including pins, plates, &c., is 398 tons. The weight of the vertical rods, flanking, &c., previous to the repairs rendered necessary by the hurricane on the 7th of January, 1838, was 246 tons, making a total weight of 644 tons, which is equal to a strain at each point of suspension of 1.100 tons. The additional flanking, &c., used in repairing the damage done by the hurricane of the 7th of January, 1838, was about 140 tons, thus making the present weight between the piers 784 tons. The sectional area of the 16 chains is 260 square inches, which, at 27 tons per square inch, will bear 7,020 tons without breaking. To insure permanence, however, the bridge should never be loaded above a quarter rate. This would produce a tension of 9 tons to the square inch, which iron will bear without stretching. At this rate the bridge would bear constantly without injury 2,340 tons, leaving a surplus power over its own tension of nearly 1,240, which is equivalent to 733 of direct weight. The area of the platform, or roadways, between the piers is 15,240 square feet. The bridge would hold, allowing 2 feet per man, 7,620 individuals. Taking them upon an average of 150 pounds, they would weigh 466 tons, being nearly 300 tons less than the bridge could constantly bear without injury.

Ibid.

Extracts from the Proceedings of the Institution of Civil Engineers.—From the London Athenæum.

Screw Propellers—Feb. 27.—The discussion on the subject of screw propellers was continued.* The main dimensions of the Princeton, United States steam frigate, were given: she is 164 feet long, 30 feet beam, 22 feet 6 inches deep in the hold, draws 17 feet 6 inches of water, and the propeller makes 32 revolutions per minute. The engines have two semi-cylindrical steam cylinders, or chests, containing vibrating pistons, or flaps, with cranks upon the ends of their suspending pivots: both these are coupled by connecting rods to a main crank on the driving shaft; the length of these cranks are so proportioned that their alternate vibrations produce a rotary motion of the main crank, and thus act directly upon the propeller without the intervention of bands, or gearing. This principle was some years since tried successfully by Captain Ericsson, in a tug boat on the Thames, named the Robert F. Stockton, after the projector, who has been the means of introducing the system into the American navy, and now commands the Princeton. It was mentioned, that recently, on being examined at Marseilles, the cast-iron propeller of the Napoleon, French steamer, was found to be much affected by the galvanic action of the copper sheathing in the salt water, and was fast turning into a substance resembling plumbago, which was so soft as to be cut easily with a knife. Some remarks were also made on the state of the metal guns recovered from the Royal George; but it appeared from examination of the effect of salt water alone upon cast-iron, without the contact of other metals to produce galvanic action, that good, hard, grey, cast-iron might be used for piles, or other hydraulic works, with great advantage, and instances were given of cast-iron which exhibited no appearance of change after sixteen years' immersion in salt water and silt.

Bridge of Cast-Iron Girders.—A paper was read giving a description, by Mr. Rhodes, of a bridge built of cast-iron girders upon timber piles, having a swivel bridge at one extremity, with an opening of 40 feet span, through which the navigation of the river was carried on. The total length of the bridge, exclusive of the width of Hayes' Island, was stated to be 558 feet 6 inches; it stretches across the river Shannon at Portumna, by 13 openings of 20 feet each, from the Tipperary shore to Hayes' Island, which is in the centre of the river, and thence by 12 openings, of a similar span, and a swivel bridge of 40 feet span, to the Galway shore. The construction, which was executed from the designs of Mr. Rhodes, was described and illustrated by drawings, showing every detail of the works, which were stated to have cost £24,131.

Bridge over the River Whitadder—March 5.—The first paper read was a description, by Mr. J. T. Syme, of the bridge over the river Whitadder, at Allanton. This bridge, which was executed at the

* See Journal of the Franklin Institute, page 299.

expense of Miss Boswall, of Blackadder, from the designs of Messrs. Stevenson & Sons, of Edinburgh, consists of two arches of 75 feet span each, with a versed sine of 11 feet 6 inches, the centre pier being 32 feet 1 inch long, and 10 feet in breadth, making the distance between the faces of the abutments 160 feet; it was constructed of soft red sand stone, and the abutments were built up solid, the greater part of the masonry being ashlar: the total cost of the bridge was stated to be £ 6,058.

Wrought-Iron Girders, and Cast-Iron Transoms.—A paper, by Mr. F. Nash, was read, describing a new kind of girder, composed of a number of diagonal bars of wrought-iron, abutting against each other, with cast-iron transoms, these latter supporting the pressure, and the former the tension. This mode of construction has been recently introduced in France for bridges, and the paper, after describing a number of preliminary experiments on small girders, gave the details of the proofs to which four girders, placed side by side, with a bearing of 74 feet 8 inches, had been subjected, by order of M. Teste, the minister of Public Works, Paris. From this it appeared that with a load of 62 tons, the deflexion in the centre was $1\frac{3}{12}$th of an inch, and that the girders resumed their original position on the weight being removed, after bearing it for a month. In order to test the effect of a sudden shock, a cart, loaded with $4\frac{1}{2}$ tons of iron, was caused to break down suddenly in the centre of the bridge, without producing any prejudicial effect beyond crushing the flooring planks. The weight of these four girders was $20\frac{1}{4}$ tons.

Wellington Bridge.—An account of the building of Wellington Bridge, over the river Aire, at Leeds, by Mr. J. Timperley, was read. This bridge was executed from the designs of the late Mr. Rennie, about twenty years since; it crosses the river where it is 100 ft. wide, and 6 ft. deep; it consists of a segmental arch of 100 feet span, with a versed sine of 15 feet, constructed of stones from the quarries of Bramley Fall, which are about four miles from the bridge; the abutments are built in radiating courses, except the external faces, which are horizontal, the whole being well bonded together; the total quantity of masonry is 80,000 cubic feet. The method of forming the foundations, as well as the coffer-dams and centre, was given in detail, and it was stated that the total cost of the bridge was only £ 7,270.

Ancient Arches.—Mr. G. Rennie made some remarks on the ancient arches, of which traces have been discovered by the recent researches of travelers, alluding to Perring's account of ancient arches discovered at Thebes, the bricks of which bore the name of Sesostris, which would carry back the knowledge of the arch to a period of upwards of three thousand years. He noticed also the use of the stone lintel among the Greeks, the Etruscan arch found in Italy, and also the more modern but very bold arches still remaining in Italy, Portugal, and Spain.

March 12.—The discussion upon the knowledge of the properties

of the arch possessed by the ancients, was renewed on the presentation, by Mr. Page, of drawings of two arches standing near some cyclopæan remains at Cape Crio (Cnidus.) There was no positive evidence of the date of these arches, but from their being built without mortar, and the massiveness of their construction, it was agreed that they were probably of the same period as the cyclopæan works among which they were situated.

Casks used in Floating large Stones.—These casks, which were strongly built of fir staves, hooped externally with iron, and supported inside by radiating bars, like the spokes of a wheel, were used, instead of crane barges, for conveying stones of thirty to forty tons weight, for securing the foot of the sea walls of Banff Harbor, which had failed. Two of these casks, of 445 feet cube each, were used to convey stones of thirty tons weight, by passing the two chain cables, which were wound round them, through the eyes of the lewises, which were fixed in the stone at low water, at which time the chains being hauled down tight, when the tide flowed, the buoyancy of the casks floated the stones, and they were towed by a boat over the place where the stone was intended to be deposited—the lashing being cut away, the stone fell into its seat. This method was found to succeed in weather that would have destroyed any crane barges; and the works of Banff Harbor were thus secured from further degradation, and were subsequently restored at a comparatively small cost. The drawings and enlarged diagrams gave the details of this method.

Railway Switch.—A model of Faram's railway switch was exhibited, and its self-acting motion, in guiding the carriages into the sidings, or on the main lines, as required, was shown by the inventor. These switches were stated to have been used on the Grand Junction Railway for some time.

Properties of the Arch—March 19.—Col. Leake made some remarks on the knowledge possessed by the Greeks of the properties of the arch; he contended that numerous example still exist of their having used it; but from the solidity of their constructions, the nature of the materials they employed, and the architectural character of the edifices, which were chiefly temples, the arch was evidently less employed than among the Romans, who used different and less solid materials.

Hydraulic Traversing Frame.—The next paper read was a description of an hydraulic traversing frame, at the Bristol terminus of the Great Western Railway, by Mr. A. J. Dodson. The action of this machine, the object of which is to transport the railway carriages from the arrival side of the terminus to the departure side, or to any one of several intermediate lines, was thus described: an opening being made in the train, the apparatus is pushed on to the line of rails, and the carriage required to be moved is run over it when the frame is quite down, it being then sufficiently low to allow the carriages to pass freely over. As soon as the carriage is brought directly over the apparatus, a man works a pump, acting upon four hydraulic

presses, which raise the frame until both sides are in contact with the axles of the carriage wheels, and raise the flanches of the wheel clear of the rails; the whole apparatus, with the carriage suspended upon it, is then easily transported to any of the lines of rails, when, by unscrewing a stopper, which allows the water to flow back from the presses into its cistern, the carriage is lowered on to the rails, and the apparatus is rolled over, ready for recommencing the operation, the whole transit not occupying more than one minute and a half. The action of the apparatus, made by Mr. Napier, was stated to be very satisfactory, and its cost to have been about £220.

American Patents.

Information to persons having business to transact at the Patent Office.

(Continued from page 312.)

Exhibition of Models and Manufactures.

Sec. 67. Models of unpatented machines, specimens of compositions, and of fabrics, and other manufactures, or works of art, will be received and arranged in the national repository of the Patent Office, as soon as the new building is finished.

Sec. 68. The personal attendance of an applicant at the Patent Office, to obtain a patent, is unnecessary. The business can be done by correspondence, (free of postage) or by attorney.

Oaths, or Affirmations.

Sec. 69. Any magistrate, having general authority to administer oaths, is qualified to take depositions in matters relating to patents.

Forms which may be used in making applications at the Patent Office:

Form of Petition.

Sec. 70. To the Commissioner of Patents:

The Petition of Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts,

Respectfully Represents:—

That your petitioner has invented a new and improved mode of preventing steam boilers from bursting, which, he verily believes, has not been known, or used, prior to the invention thereof by your petitioner. He, therefore, prays that letters patent of the United States may be granted to him therefor, vesting in him, and his legal representatives, the exclusive right to the same, upon the terms and conditions expressed in the act of Congress in that case made and provided; he having paid thirty dollars into the Treasury, and complied with other provisions of said act.

Sebastian Cabot.

Form of Specification.

Sec. 71. To all whom it may concern:

Be it known, that I, Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts, have invented a new and improved mode of preventing steam boilers from bursting, and I do hereby declare that the following is a full and exact description thereof:

The nature of my invention consists in providing the upper part of a steam boiler with an aperture, in addition to that for the safety-valve, which aperture is to be closed by a plug, or disk, of alloy, which will fuse at any given degree of heat, and permit the steam to escape, should the safety-valve fail to perform its functions.

To enable others, skilled in the art, to make and use my invention, I will proceed to describe its construction and operation: I construct my steam boiler in any of the known forms, and apply thereto gauge-cocks, a safety-valve, and the other appendages of such boilers; but, in order to obviate the danger arising from the adhesion of the safety-valve, and from other causes, I make a second opening in the top of the boiler, similar to that made for the safety-valve, as shown at A, in the accompanying drawing; and in this opening I insert a plug, or disk, of fusible alloy, securing it in its place by a metal ring and screws, or otherwise. This fusible metal, I, in general, compose of a mixture of lead, tin, and bismuth, in such proportions as will insure its melting at a given temperature, which must be that to which it is intended to limit the steam, and will, of course, vary with the pressure the boiler is intended to sustain. I surround the opening containing the fusible alloy by a tube B, intended to conduct off any steam which may be discharged therefrom. When the temperature of the steam, in such a boiler, rises to its assigned limit, the fusible alloy will melt, and allow the steam to escape freely, thereby securing it from all danger of explosion.

What I claim as my invention, and desire to secure by letters patent, is the application to steam boilers of a fusible alloy, which will melt at a given temperature, and allow the steam to escape, as herein described; using for that purpose any metallic compound which will produce the intended effect.

Witness: { John Doe.
Richard Roe. } Sebastian Cabot.

Sec. 72. When the application is for a machine, the specification should commence thus:

Be it known, that I, , of , in the county of , and State of , have invented a new and useful machine for—[stating the use and title of the machine; and if the application is for an improvement, it should read thus: A new and useful improvement on a, or on the, machine, &c.] —and I do hereby declare that the following is a full, clear, and exact description of the construction and operation of the same, reference being had to the annexed drawings, making a part of this specification, in which fig. 1, is a perspective view; fig. 2, a longitudinal elevation; fig. 3, a transverse section, &c., [thus describing all the sections

of the drawings, and then referring to the parts by letters.] Then follows the description of the construction and operation of the machine, and ending with the claim, which should express the nature and character of the invention, and identify the part, or parts, claimed separately, or in combination. If the application is for an improvement, the original invention should be disclaimed, and then the claim confined to the improvement.

Form of Oath.

SEC. 73. County of Hampden, State of Massachusetts, ss:

On this day of , 183 , before the subscriber, a personally appeared, the within named Sebastian Cabot, and made solemn oath, [or affirmation,] that he verily believes himself to be the original and first inventor of the mode herein described for preventing steam boilers from bursting, and that he does not know, or believe, the same was ever before known, or used: and that he is a citizen of the United States.

(Signed) A. B.

Form of Withdrawal.

SEC. 74. To the Commissioner of Patents:

Sir,—I hereby withdraw my application for a patent for improvements in the steam boiler, now in your office, and request that twenty dollars may be returned to me, agreeably to the provision of the act of Congress authorizing such withdrawal.

SEBASTIAN CABOT.

Cabotville, Mass., March 1, 1838.

Form of Surrender of a Patent for Reissue.

SEC. 75. To the Commissioner of Patents:

The Petition of Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts,

Respectfully Represents:—

That he did obtain letters patent of the United States, for an improvement in the boilers of steam engines, which letters patent are dated on the first day of March, 1835. That he now believes that the same is inoperative and invalid, by reason of a defective specification, which defect has arisen from inadvertence and mistake. He, therefore, prays that he may be allowed to surrender, and he hereby does surrender, the same, and requests that new letters patent may issue to him for the same invention, for the residue of the period for which the original patent was granted, under the amended specification herewith presented; he having paid fifteen dollars into the Treasury of the United States, agreeably to the requirements of the act of Congress in that case made and provided.

SEBASTIAN CABOT.

Form of Assignment of a Right in a Patent.

SEC. 76. *Whereas,* I, Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts, did obtain letters patent of the United States, for certain improvements in steam engines, which

letters patent bear date the first day of March, 1835; and whereas, John Doe, of Cabotville, aforesaid, is desirous of acquiring an interest therein: *now this indenture witnesseth*, that, for, and in consideration of the sum of two thousand dollars, to me in hand paid, the receipt of which is hereby acknowledged, I have assigned, sold, and set over, and do hereby assign, sell, and set over, all the right, title, and interest, which I have in the said invention, as secured to me by said letters patent, for, to, and in, the several States of New York, New Jersey, and Pennsylvania, and in no other place, or places; the same to be held and enjoyed by the said John Doe, for his own use and behoof, and for the use and behoof of his legal representatives, to the full end of the term for which said letters patent are, or may be, granted, as fully and entirely as the same would have been held and enjoyed by me, had this assignment and sale not have been made.

In testimony whereof, I have hereunto set my hand, and affixed my seal, this first day of March, 1838.

Witness: { A. B. C. D.   SEBASTIAN CABOT, [L. S.]

Form of Disclaimer.

SEC. 77. To the Commissioner of Patents:

The Petition of Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts,

Respectfully Represents:—

That he has, by assignment, duly recorded in the Patent Office, become the owner of a right, for the several States of Massachusetts, Connecticut, and Rhode Island, to certain improvements in the steam engine, for which letters patent of the United States were granted to John Doe, of Boston, in the State of Massachusetts, dated on the first day of Mach, 1835. That he has reason to believe that, through inadvertence and mistake, the claim made in the specification of said letters patent is too broad, including that of which the said patentee was not the first inventor. Your petitioner, therefore, hereby enters his disclaimer to that part of the claim in the afore named specification, which is in the following words, to wit: "I also claim the particular manner in which the piston of the above described engine is constructed, so as to insure the close fitting of the packing thereof to the cylinder, as set forth;" which disclaimer is to operate to the extent of the interest in said letters patent vested in your petitioner, who has paid ten dollars into the Treasury of the United States, agreeably to the requirements of the act of Congress in that case made and provided.

SEBASTIAN CABOT.

When the disclaimer is made by the original patentee, it must, of course, be so worded as to express that fact.

Form of Caveat.

SEC. 78. To the Commissioner of Patents:

The Petition of Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts,

Respectfully Represents:

That he has made certain improvements in the mode of construct-

ing the boilers of steam engines; and that he is now engaged in making experiments for the purpose of perfecting the same, preparatory to his applying for letters patent therefor. He, therefore, prays that the subjoined description of his invention may be filed as a *Caveat*, in the confidential archives of the Patent Office, agreeably to the provisions of the act of Congress, in that case made and provided; he having paid twenty dollars into the Treasury of the United States, and otherwise complied with the requirements of the said act.

SEBASTIAN CABOT.

Cabotville, March 1, 1838.

SEC. 79. Here should follow a description of the general principles of the invention, so far as has been completed.

Form for Addition of New Improvements.

SEC. 80. To the Commissioner of Patents:

The Petition of Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts,

Respectfully Represents:—

That your petitioner did obtain letters patent of the United States, for an improvement in the boilers of steam engines, which letters patent are dated on the first day of March, 1835; that he has since that date, made certain improvements on his said invention; and that he is desirous of adding the subjoined description of his said improvements to his original letters patent, agreeably to the provisions of the act of Congress, in that case made and provided; he having paid fifteen dollars into the Treasury of the United States, and otherwise complied with the requirements of the said act.

SEBASTIAN CABOT.

SEC. 81. *Form of Assignment before obtaining Letters Patent, and to be Recorded preparatory thereto.*

Whereas, I, Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts, have invented certain new and useful improvements in the boilers of steam engines, for which I am about to make application for letters patent of the United States; and whereas, John Doe, of Cabotville, aforesaid, has agreed to purchase from me all the right, title, and interest which I have, or may have, in, and to, the said invention, in consequence of the grant of letters patent therefor, and has paid to me, the said Cabot, the sum of five thousand dollars, the receipt of which is hereby acknowledged. Now, this indenture witnesseth, that for, and in consideration of, the said sum to me paid, I have assigned and transferred, and do hereby assign and transfer, to the said John Doe, the full and exclusive right to all the improvements made by me, as fully set forth and described in the specification which I have prepared and executed preparatory to the obtaining of letters patent therefor. And I do hereby authorize and request the Commissioner of Patents to issue the said letters patent to the said John Doe, as the assignee of my whole right and title thereto, for the sole use and behoof of the said John Doe, and his legal representatives.

In testimony whereof, I have hereunto set my hand, and affixed my seal, this first day of March, 1838.

Witness: { A. B. / C. D. }   Sebastian Cabot, [L. S.]

Sec. 82. *Form of Oath on Restoring Drawings, or Sketches, from which Drawings may be made, to replace the originals destroyed in the Office.*

County of Hampden, State of Massachusetts, ss:

On this first day of March, 1838, before the subscriber, a , personally appeared, Sebastian Cabot, of Cabotville, in the State of Massachusetts, and made solemn oath that he is the inventor [or is interested in the invention, as administrator, &c.] of an improved mode of preventing the explosions of steam boilers, for which letters patent of the United States were granted to him, dated the first day of January, 1835, and that the annexed drawing, or sketch, is, as he verily believes, a true delineation of the invention described in the said letters patent.

Sec. 83. If the following questions can be answered affirmatively before transmitting the papers, few applications will be returned for correction, or omissions:—

1. Is the fee transmitted?
2. Is the petition signed, and addressed to the Commissioner of Patents?
3. Is the specification signed, and witnessed by two witnesses?
4. Are the drawings described, and referred to in the specification? If not, are they signed before two subscribing witnesses, and are they accompanied with written references?
5. Are duplicated drawings sent?
6. Has the inventor made oath to his being a citizen, and that his invention is new?
7. Does the specification contain a specific claim?
8. If an alien and resident, is this affirmed, or sworn, to?
9. Has the model been sent, and how?
10. Is the name of the inventor durably affixed to the same?
11. In case of reissue, is the old patent surrendered?
12. Has the oath of invention been renewed, before appealing from the decision of the Commissioner?
13. Have the fees been remitted in coin, or by certificate of deposit?
14. In case of reissue, disclaimer, addition of an improvement, or patent for an improvement on an existing patent to inventor, assignee, or possessor, of the original patent, have model and drawings of the original patent (if granted before the 15th of December, 1836,) been transmitted?

Information under the Act of August 29, 1842.

Art. 1. This act authorizes the Treasurer of the United States to repay any money which has been paid into the Treasury by actual

mistake, as for patent fees, thus precluding the necessity of special application to Congress for relief.

Art. 2. The privilege of renewal of lost patents is now extended to those *granted* before the fire of December, 1836. Heretofore it has been limited to those actually *lost* before the fire, thus excluding many lost subsequently, and before they were recorded anew in this office, leaving the inventor without remedy.

Art. 3. Protection is by this act extended to a *new* class of objects, viz :—

To new and original *Designs :*

— for a manufacture of metal and other materials :

— for the printing of woolen, silk, cotton, or other fabrics :

— for busts, statues, or bas relief, or composition in alto, or basso, relievo :

— for any impression, or ornament, or to be placed on any article of manufacture in marble, or other material :

— for any new and useful pattern, print, or picture, to be in any manner attached to, or fixed on, any article of manufacture :

— for any new, or original, shape, or configuration, of any article of manufacture ; all such designs not being previously known, or used by others.

Art. 4. American ministers, consuls, &c., residing abroad, may administer the oath required for applicants not resident in the United States. Heretofore such functionaries were not authorized to perform this act, thus subjecting applicants, in foreign countries, to much inconvenience.

Art. 5. The stamping, or affixing, the name of any patentee on any article without authority so to do, or the affixing the word *patent*, or *letters patent*, or the stamp, mark, or device of any patentee on any unpatented article, for the purpose of deceiving the public, is forbidden under a penalty not less than one hundred dollars.

Art. 6. Patentees, or their assignees, are now required to affix the date of the patent on each article vended, or offered for sale, under a like penalty—thus affording to the public notice of the duration of the patent—when the article is of such a nature that the date cannot be printed thereon, it should be affixed to the case, or package, containing it.

It will be observed that this act does not repeal, or change, the law under which patents have heretofore been granted, but is merely additional thereto—all patents, except for *designs*, being granted for fourteen years, and the fee, as hitherto, being thirty dollars.

Before the grant of any patent under this act, the application must be made by petition to the Commissioner of Patents, signed by the inventor.

He is also required to furnish a written description, or specification, of his invention, or production, in which the same shall be fully and

clearly described—such specification to be signed, witnessed by two witnesses, and verified by his oath, or affirmation.

In all cases which admit of representation by drawings, the application must be accompanied by duplicate drawings, and a specimen—and in other cases by duplicate specimens.

The provisions of the 6th Section do not apply to patents granted prior to the passage of this act.

Forms of Application for Patents on Designs under the Act of August 29, 1842.

To the Commissioner of Patents:

The Petition of Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts,

Respectfully Represents:—

That your petitioner has invented, or produced, [a new design, or figure, to be stamped, or printed on fabrics, which, when thus printed, are termed calicoes,] which he verily believes has not been known prior to the production thereof by your petitioner. He, therefore, prays that letters patent of the United States may be granted to him therefor, vesting in him, and his legal representatives, the exclusive right to the same, upon the terms and conditions expressed in the act of Congress, in that case made and provided; he having paid fifteen dollars into the Treasury, and complied with other provisions of the said act. SEBASTIAN CABOT.

Specification.

To all whom it may concern:—

Be it known, that I, Sebastian Cabot, of Cabotville, in the county of Hampden, and State of Massachusetts, have invented, or produced, a new design, or figure, to be printed on fabrics, which, when thus printed, are termed calicoes, and I do hereby declare that the following is a full and exact description of the same. [Here follows a description of the design, or figure, with reference to the specimen, or to a drawing of it, in all cases which admit of representation by drawings.]

The specification to conclude with declaring what the inventor, or producer, claims, to be expressed in terms which will give the character of the design, &c.

Form of Oath.

County of Hampden, State of Massachusetts, ss:

On this day of 184 , before the subscriber a personally appeared the within named Sebastian Cabot, and made solemn oath, or affirmation, (as the case may be,) that he verily believes himself to be the original and first inventor, or producer, of the design for figures to be printed on fabrics, which, when thus printed, are termed calicoes, and that he does not know, or believe, that the same was ever before known, or used, and that he is a citizen of the United States.

(Signed) A. B.

The phraseology of the title of this act having misled many per-

sons, it is proper to add that it is an act in addition to the act of July 4, 1836, by which act all acts and parts of acts before made, were *then* repealed. The title of the act of August 29, 1842, therefore, merely recites the title of the act of 1836.

HENRY L. ELLSWORTH,
Commissioner of Patents.

Patent Office, Nov. 5, 1842.

All Communications should be addressed to the Commissioner of Patents.

In consequence of the numerous applications to this office for information, founded on brief descriptions of inventions, and asking, in any given case, whether there exists any thing like the invention described, and whether a patent can be had therefor, it has become necessary to furnish the explanation following, as a general reply to such inquiries.

By the act of July 4, 1836, entitled "An act to promote the useful arts, and to repeal all acts and parts of acts heretofore made for that purpose," a principle entirely new was engrafted upon the system, under which patents had been previously granted.

Under the provisions of this act, it was made the duty of the Commissioner of Patents, on the receipt of any application for a patent, to institute "an examination of the alleged new invention, or discovery," with the view to determine whether the same had been before "invented, or discovered, by any other person in this country," "or patented, or described, in any printed publication, in this, or any foreign, country." Thus was the grant of patents in future restricted to such "inventions, or discoveries," as were *new*, in the most absolute sense of the term; and a very laborious and responsible duty imposed upon this office. In aid of the solution of the question of *novelty*, thus raised on every application, the applicant was required to furnish a full and clear description of his invention, signed, witnessed, and verified by his oath, accompanied by a model and drawings of the same; all being deemed necessary in order to illustrate his claim to a patent. Furnished with these illustrations, the office was then required to go into a rigorous and extended examination, taking in the whole range of history on the given subject, whether its evidences were to be found in patents granted, caveats filed, or descriptions published, in this, or in any foreign, country, in any period of time.

In the conduct of these examinations, it is necessary to keep in constant and laborious employment, a number of persons specially selected for their knowledge and skill in the arts; to refer, with guarded care, to caveats filed in the secret archives of the office, and which can only come into view on such occasions; to patents already granted, and to such works on the arts as have been published here, or elsewhere; and also to keep pace with the current of invention throughout the world, by a constant and copious supply of such publications in this country and in Europe as are devoted to this object.

It will readily be seen that this office cannot undertake to respond

to the numerous inquiries constantly addressed to it, whether such, or such, an invention be new, and whether a patent can be obtained for it. Because, 1st, every such inquiry involves the *whole question of novelty;* and before the office could express, or even form, an opinion, would require the same range of rigorous examination as is now required by law on a regular application for a patent, and this too without the necessary illustrations; such inquiries being based on mere, and usually very imperfect, general descriptions; while, in the case of application for patents, the law requires that the office shall have the aid, not only of clear and full description, under oath, but also accurate drawings and models, before it shall decide the question whether, in any given case, the invention be *new,* &c.

2nd. The attempt to do so would effectually interrupt the appropriate business of the office, and be a direct infringement on the rights of those who apply for patents; as the regular examinations of their applications must necessarily be suspended, while the examinations required, in order to frame such answers, were being made.

3rd. Every such inquiry does, in effect, require this office to prejudge a case before such case is presented; or, in other words, the inquirer asks of the office to decide upon his invention before he has done that which the law requires he shall do, in order to obtain such decision.

4th. The law has made no provision for such services. It is, therefore, no part of the legitimate duty of this office.

It is hoped that this explanation will prove satisfactory to all, and that it will be distinctly understood, that, in declining to respond to the class of inquiries above stated, this office acts under the mere necessity of the case, and not from any disposition to withhold information.

The records and models of the office are always open to inspection, and copies can readily be furnished on receipt of the fee required by law.

Models.

Sec. 84. If deposited with any of the following agents, will be forwarded to the Patent Office, free of expense.

John N. Sherburne, Collector at Portsmouth, New Hampshire.
Nathan Cummings, Collector at Portland, Maine.
William P. Briggs, Collector at Burlington, Vermont.
William R. Watson, Collector at Providence, Rhode Island.
R. H. Eddy, Agent at Boston, Massachusetts.
Perry Smith, Surveyor at Hartford, Connecticut.
Edgar Irving, Agent, Custom House, New York.
Calvin Blyth, Collector at Philadelphia, Pennsylvania.
Nathaniel F. Williams, Collector at Baltimore, Maryland.
Thomas Nelson, Collector at Richmond, Virginia.
W. J. Grayson, Collector at Charleston, S. Carolina.
James Hunter, Collector at Savannah, Georgia.
T. Gibbs Morgan, Collector at New Orleans, Louisiana.
Edward Brooks, Collector at Detroit, Michigan.

J. H. Lathrop, Collector at Buffalo, New York.
Surveyor at St. Louis, Missouri.
William Milford, Collector at Cleveland, Ohio.
John Willock, Surveyor at Pittsburgh, Pennsylvania.
Isaiah Wing, Surveyor at Cincinnati, Ohio.
N. P. Porter, Surveyor at Louisville, Kentucky.

Sec. 85. The transmission of models by the agents extends to those for new applications, as well as those restored in consequence of the destruction of the originals.

Sec. 86. N. B.—*Patentees,* and the public in general, are urged to use their influence to aid the office in restoring the records of all patents and assignments on record before the fire in December, 1836. The same cannot be used in evidence, unless *so recorded anew.* No expense is incurred. The papers are received and transmitted by mail.

H. L. Ellsworth.
Commissioner of Patents.

List of Banks which are authorized to receive Patent Fees on account of the Treasury of the United States, and to give receipts, or certificates of deposit therefor, viz:

Merchants' Bank, at Boston, Massachusetts.
Arcade Bank, at Providence, Rhode Island.
Bank of Commerce, at New York.
Bank of the Metropolis, at Washington, D. C.
Bank of Washington, D. C.
Southwestern Railroad Bank, Charleston, S. C.
Louisville Savings Institution, Louisville, Ky.
Norwalk Bank, at Norwalk, Ohio.
Ohio Life Insurance and Trust Company, Cincinnati, Ohio.
Farmers and Mechanics' Bank, at Hartford, Ct.
Piscataqua Bank, at Portsmouth, N. Hampshire.
Exchange Bank, at Pittsburgh, Penna.
Bank of Missouri, at St. Louis, Missouri.
Merchants' Bank, at Baltimore, Maryland.
Philadelphia Bank, at Philadelphia, Penna.
Bank of America, at New York.
Union Bank of Tennessee, at Nashville, Tennessee.
Union Bank of Louisiana, at New Orleans, La.

Any person wishing to pay a patent fee may deposit it with either of the banks above named, and forward the receipt, or certificate, to this office, as evidence thereof.

Request.

Congress having authorized the collection and distribution of seeds through this office, a transmission to this place of any rare and useful seeds, may confer a great benefit on the community, and will, so far as practicable, be reciprocated by the Commissioner of Patents. A history of the seed transmitted, together with the place of production is respectfully solicited.

H. L. Ellsworth.

Mechanics, Physics, and Chemistry.

On Madder. *By* M. Girardin, *Prof. Pract. Chem. at the Municipal School of Rouen.*

(Continued from Page 340.)

V.—*On the Adulteration of Madders, and Methods of Detecting them.*

On account of the high price of madder, and especially from the facility of introducing into this substance, which is sold in the form of powder, foreign pulverulent matters, which the most practiced eye cannot detect, this root is subject to a number of sophistications which cannot be too fully exposed.

There are two kinds of adulteration. Sometimes earthy, or mineral, substances are incorporated with the powder of madder; sometimes vegetable substances are added to it, the color of which resembles that of madder.

1. *Adulteration by Mineral Substances.*—The mineral substances which have been introduced, or which are still found in ground madders, are brick dust, red and yellow ochre, yellowish sand, yellowish clay, or argillaceous earth. A madder which contains earthy substances grates between the teeth when chewed.

A small quantity of such a madder, for example, from 25 to 30 grms., introduced into a large glass globe, and diluted with 5 or 6 litres of water, quickly deposits the greater portion of the earthy substances at the bottom of the vessel. When the suspended madder is decanted, and the deposit agitated with a fresh quantity of water, the earthy substances are isolated, and may be examined.

However, to determine the proportion, more exact processes must be had recourse to. The best is that of calcining, at a red heat, in a platinum crucible.

5 grms. of the madder under examination, are first dried completely at 212° Fahrenheit, and are weighed with great exactness, and then put into the platinum crucible, which must be weighed before hand. The crucible is shut, and heat gradually applied. When perfectly incinerated, the crucible, is taken out of the furnace, and left to cool, and then weighed. Its weight being deducted from the quantity employed, the difference gives the proportion of cinders obtained.

These cinders are composed, 1st, of the fixed mineral matters contained in the root; and 2nd, of the earthy substances, foreign to the chemical constitution of the root, and which have been accidentally, or fraudulently, mixed with the madder.

Some experiments which I made with M. Labillardière on a large scale, in 1828, showed us that madder which is very pure, and quite free from its epidermis, or any foreign earthy matter, and dried with care, gives, by incineration, 5 per cent. of ash; that the Lizaris of Provence, stripped of its pellicle, gives, on an average, 8.80 per cent. of ash.

According to M. Henri Schlumberger, 100 parts of Alsatian Lizaris, washed in distilled water, and dried at 212°, give 7.20 per cent. of ash; whilst 100 parts of Lizaris of Avignon, prepared in the same way, give 8.766.

According to M. Chevreul, 100 parts of Lizaris, from the Levant, dried at 212°, give 9.80 ash.

When an Avignon madder, SFF (the mark most generally used,) subjected to the test of incineration, gives a greater weight of ash than 5 per cent., which I have taken as the mean of numerous experiments, the excess must be attributed to the presence of foreign earthy, or sandy, matters, either arising from adulteration, or a careless preparation of the powder.

When the excess is only from three to four-hundredths, it is probably owing to some fault in the preparation of the madder, the manufacturer not having separated the epidermis, which is always coated with the earth which surrounds the root, carefully enough by grinding; but when the excess is above 4 or 5 per cent., or more, it is the result of fraud.

The madders obtained from the merchants give very variable results, with respect to the proportion of ash which they furnish, as the following table shows:—

	Per Cent. of Ash.
On 6 trials the mulle madder of Avignon gave	4.00
On 7 trials the madder SF of Avignon gave from	12.40 to 20.00
On 18 trials the madder SFF of Avignon gave from	7.40 to 23.00
On 4 trials the madder SFFRP of Avignon gave from	12.00 to 16.00
On 3 trials the madder SFFP of Avignon gave from	10.00 to 10.80
On 7 trials the madder EXTF of Avignon gave	10.00

When, in testing a madder by incineration, the quantity operated on amounts to 5 grammes, the weight of the ash must be multiplied by 20, in order to bring it to 100 parts, and from the figure obtained 7 parts, representing the mean weight of ash p. c. furnished by good madder, subtracted; the surplus then represents the proportion of earthy matters, or of sand, added by the manufacturer. Consequently a madder furnishing 16.40 per cent. of ash will contain 9.40 per cent. of foreign matter.

2. *Adulteration by Vegetable Substances.*—The vegetable substances which are introduced into the madders, are powders of little, or no, value, such as saw dust, almond shells, bran, the bark of the so called pine tree, mahogany wood, log wood, sandal wood, and fir tree wood.

The sophistication of madders by these different substances, is much more prejudicial to the dyer than that by mineral substances; for, besides diminishing, like the latter, the quantity of coloring matter of a given weight of madder, they also injure the dye, either by absorbing the coloring matter, or by preventing the colors becoming so bright.

Unfortunately, the means of detecting this new kind of fraud are neither so rigorous nor so simple as the process for determining the presence of mineral matters. It is extremely difficult to ascertain

with what kind of vegetable substance a madder has been adulterated; it is mostly only possible to ascertain that there is a mixture. This, however, is the most important point, and the practical man, after all, only needs to know the tinctorial worth of the madder which he buys.

Many methods have been proposed to determine the tinctorial value of madders, and the absolute quantity of the coloring principle which they contain; but the greater part of them have the fault of being too exact, or too difficult, and too long of execution. I will now point out those which I think preferable, and which I have long since employed in the examination of madders which I continually make.

One of these means consists in determining the coloring power by means of Labillardière's colorimeter; the second, in determining this coloring power, as well as the solidity and brilliancy of the colors, by an operation of dyeing. The third experiment is to ascertain the absolute quantity of the coloring principle.

These different experiments are always made comparatively, by taking for type a madder prepared with all possible care, and having the same marks as that under examination. As with indigo and other tinctorial substances, a single experiment is not sufficient; and by reason of the difficulty there is of correctly verifying the value, or the quality, of the madders, it is indispensable, in order to decide with any certainty, to check the experiments by each other. This is the only way of obtaining satisfactory results.

1. *Determination of the Coloring Power by the Colorimeter.*—The following is the mode of operation with the colorimeter of Labillardière. The type madder, and the madder under examination, are dried at 262° Fahr., and an account is kept of the respective quantities of hygrometric water they contain.

25 grammes of each sample are then mixed with 250 grammes of water at 68°. After 3 hours of contact, the whole is thrown upon a linen cloth. A second maceration is made with the same amount of water, and for the same length of time. The madders are then washed with 250 grms. of cold water, dried at 212°, and weighed, in order to ascertain the proportions of soluble, saccharine, and mucilaginous matters which they have lost by these preliminary washings, which only remove an insignificant quantity of red coloring matter.

5 grms. of each of the two madders are then introduced into little glass globes with 40 parts of water, and 6 parts of very pure alum, boiled for a quarter of an hour, and the boiling liquids filtered. The grounds are washed with 2 parts of hot water. Two other decoctions, similar to the first, are made, and each time the residue is washed with 2 parts of hot water. The products of the three decoctions are combined, and the liquids from the two samples of madder compared by the colorimeter.

Without doubt this examination with the colorimeter is not sufficiently accurate, but it affords valuable indications, which, joined to those resulting from the following tests, enable us to give a decided opinion.

2. *Determination of the Tinctorial Power by Dyeing.*—In order to estimate the value of a madder by dyeing, a madder of superior quality must be taken, as a type of comparison, with which skains, or mordanted calicoes, have been already dyed, by acting with determinate quantities of powder, tissue, and water. Patterns for comparison should be prepared in the following manner:—

Calicoes are selected, mordanted for red and black, and well cleansed in a dung bath. They are divided into pieces 5 centimetres square, and are dyed with proportions of madder increasing progressively from 1 grm. up to 10 grms., so as to have a scale of 10 shades, of which the gradations represent each a known weight of madder. The garancing of these pieces is practiced in the following manner: In a great copper basin, with a flat bottom, which is covered with a layer of hay, are placed three or four glass jars with wide mouths, containing from 1½ litre to 2 litres. The basin is filled with ordinary water heated to 104°, then into each of the glass jars the piece of mordanted calico is introduced, the madder weighed with care, and lastly, three-fourths of a litre of distilled water, heated to a temperature of 104°. A thermometer is inserted in the water bath, which is heated slow enough for the water not to reach 167°, until after an hour and a half, avoiding carefully alternations of temperature. After this is made to boil for half an hour, the samples are taken out, rinsed in cold water, and dried. Each dyed piece is cut in half; one-half is preserved as it is, the other is subjected to the following clearings:—We begin by a soap bath at 122°, made with 2½ grms. of white soap, to each litre of water. After it has been half an hour in this bath, the cloth is carefully rinsed in cold water. A fresh soap bath is given, to which is added half a gramme of salt of tin, and which is kept at a boiling point for half an hour. It is washed and rinsed. The well rinsed samples are dried with care, and preserved from the light.

When a series of tints of two different states have been thus prepared, that is to say, a dye without and with clearing, it is very easy to ascertain the comparative value of an unknown madder. In fact, it is sufficient to take 10 grms. from the barrels, and to go through the preceding operations on 5 square centimetres of suitably mordanted calico, and to compare the dye obtained, before and after the clearing, with the ten samples. If, for example, the shade is equivalent to No. 5 of the madder, it may be concluded that the unknown madder is inferior by half to the madder type, since $10:5::100:x=50$.

Whatever vegetable powders may have been fraudulently introduced into the madders, whether tinctorial, or inert, they can never lead to error as to the true tinctorial value of the mixture, inasmuch as the colors which they afford, and which saturate the mordants at the same time as the red principle of the madder, cannot withstand the action of the clearings as the latter does; they *run*, as is said, in the soap and tin baths, and in the end there only remains the color from the madder upon the tissue. The clearings are, therefore, necessary to show the solidity and vivacity of the tints obtained.

Instead of printed calicoes, skains of oiled and mordanted cotton may be used in the state in which they are prepared for dyeing

Turkey red. In this case skains of the weight of 10 grms. are taken, and dyed with different weights of good madder, from 20 to 30 grms., in order to obtain a scale of ten distinct shades.

This test is that which I have employed since 1831, and which has been since adopted in all our print works of Rouen and Bolbec, where my pupils have introduced it. It differs very little from that which was published in 1835, by M. H. Schlumberger of Mulhausen.*

3. *Determination of the Quantity of the Coloring Principle.*—The most exact process hitherto published, is, without doubt, that made known by M. H. Schlumberger in 1838,† as modified by M. Scheurer.‡ But this process, which is founded on the solubility of the red coloring principle of the madder in weak acetic acid, a fact pointed out as early as 1829, by an anonymous chemist,‖ is, unfortunately, too sensitive, and requires too great a degree of skill in the manipulation, to become general.

The following is the method which I have long been accustomed to employ:—50 grms. of madder are diluted with 50 grms. of concentrated sulphuric acid. The whole is left in contact for some hours: too high a temperature should be avoided; the charcoal obtained is mixed with water, and thrown upon a filter; it is then washed until the water passes through quite insipid; and next dried at a temperature of 212° Fahr., in Gay-Lussac's water bath. This charcoal is reduced to a fine powder, and macerated for two hours at three distinct intervals, with cold alcohol containing a little ether, in order to free it from a fatty matter which it retains. The powder is boiled in alcohol of 0.834, at three different intervals, employing each time about 250 grms. of alcohol. When this is no longer colored by ebullition, the alcoholic liquors are mixed, and distilled in a small glass retort to the consistence of a sirop, and the concentration of the liquid completed in the water bath in a weighed porcelain crucible. When the extract is perfectly dry, its weight is taken. This represents the proportion of red tinctorial principle contained in the madder.

This process is rather long; it does not give, especially on a small scale, the absolute proportion of coloring principle contained in the madder; there is a slight loss, but by acting comparatively a sufficient approximation is obtained.

Such are the different methods for ascertaining the quality, the purity, or the adulteration, of the madders. In most cases calcination is sufficient, and rigorously, calcination and the test by dyeing made conjointly, allow the practitioner to form a positive opinion of the value of the madders submitted to examination.

Considering the minutiæ, and the number of operations which it is necessary to have recourse to, in order to form a just estimate of the relative worth of the madders, it is evident that an examination of the madders by simply looking at them, as is customary with the merchants, can afford no precise information, and must, indeed, lead, in most cases, to erroneous conclusions. The process in use amongst merchants consists in spreading samples of madders of about 30 to 40

* Bulletin de la Société Industrielle de Mulhausen, viii, p. 300.
† Id., xi, p. 323. ‡ Id., xi, p. 339. ‖ Id., ii, p. 407.

grammes side by side on a sheet of paper, which small heaps are flattened, and their surfaces rendered smooth with the back of an ivory spatula. The samples are then placed in a cellar, or some moist situation, where they remain from twelve to fifteen hours. At the expiration of this time the quality is judged of according to the brightness and tint of the powder.

But as M. H. Schlumberger* has already observed, this method does not even approximately show the richness of color of the madders, since a somewhat long contact with the air is sufficient to render them darker, and many circumstances may change their tint, without thereby causing their tinctorial value to vary. On the other hand, the old madders, of a dull tint, may be far superior to others of a more beautiful color. The merchants' and brokers' method of trial often places the manufacturer in a false position, by obliging him to brighten the tint of his powders, in order to make them more saleable, and that sometimes to the injury of the tinctorial power; thus facilitating the adulteration of the madders by mixture with foreign substances, suitably colored and pulverized, which serve to heighten the tint of the powder; and it is impossible to ascertain the presence of these mixtures by exposure in the cellar, of which I have often had proofs. I have purposely made mixtures of madder, of powders of mahogany and of sandal wood in known proportions, and these mixtures, when tried by the merchants, who thought themselves very skilful in their estimation of madders, by the above process, were considered by them to be pure madders of first quality!

Testing of the Garancines.—The quality of the garancines varies, as I have already stated, considerably. A manufacturer sometimes sends a series of from fifteen to twenty barrels of excellent quality, and fifteen days later sends another series which is worth from 20 to 25 per cent. less than the preceding one. It often happens that in the same series good and bad garancine is found; each barrel, therefore, of this product should be tested comparatively, as far as possible. It is now customary for the seller to take back the garancines which he had delivered to the calico printer, allowing for the pieces spoiled, when the quality of the powders was inferior to what it was represented.

The testing of garancines is made on a large and on a small scale. In the latter case the following is the process we adopt:—

Samples are taken from the barrels as they arrive, taking care to cork the labeled bottles in which they are inclosed as quickly as possible, in order that they may not dry, which, in summer time especially, causes an amelioration of from 5 to 6 per cent. in a few days, on account of the water which evaporates.

A piece of calico, printed in stripes of red, violet, puce, and garnet, is taken, (black is useless, as all the garancines produce that well,) not gummed as usual, and dried. As many decimetres are cut from it as there are garancines to be tried, and the pieces are marked by notching them with the scissors: the notches must correspond with the numbers on the bottles.

* Bulletin de la Société de Mulhausen, xi, p. 318.

From 1.9 grm. to 2 grms. of garancine, known to be good, is weighed off to serve as a standard, and for the garancines to be tried, we take 1, 2, 3, 4, 5, 6, 7, 8, 10 times, more, or less, of 1.90, or 2 grammes, according as they cost, 1, 2, 3, 4, &c., more, or less, than the standard sample. As the samples are weighed, they are each put into a jug with a wide mouth holding half a litre, with from 2 to 2½ decilitres of water containing some oxalic acid, in the proportion of 15 centigrammes to a litre. The jugs are numbered so as to correspond with the samples of the garancines and strips of calico. They are placed in a water bath, in a copper boiler with a flat bottom, the pieces of printed calico are immersed in them, and dyed as in testing the madders, regulating the fire so as to raise the temperature to 158° in an hour and a half, and keeping it at the boiling point for half an hour. After the process of dyeing, the samples are removed as quickly as possible from the vessels, rinsed in water, and beaten, and then dried, or previously immersed for five or six minutes in a bran bath at 167°. When dry they are compared, and in this manner the relative tinctorial value of the garancines may be estimated as nearly as possible.

In employing calicoes, which present at the same time stripes mordanted for red, violet, puce, and garnet, it is seen at once whether the garancines can be employed with advantage for all the colors, or for what tints they are most suited. I have already stated that the same garancine does not always suit equally well for red, puce, and violet. —*Journ. de Pharm. for Nov. and Dec.*, 1843.

London Chemical Gazette.

A speculation touching Electric Conduction, and the Nature of Matter. By MICHAEL FARADAY, Esq., D. C. L., F. R. S.

Last Friday I opened the weekly evening meetings here, by a subject of which the above was the title, and had no intention of publishing the matter further, but as it involves the consideration and application of a few of those main elements of natural knowledge, facts, I thought an account of its nature and intention might not be unacceptable to you, and would, at the same time, serve as the record of my opinion and views, as far as they are at present formed.

The view of the atomic constitution of matter, which, I think, is most prevalent, is that which considers the atom as a something material having a certain volume, upon which those powers were impressed at the creation, which have given it, from that time to the present, the capability of constituting, when many atoms are congregated together into groups, the different substances whose effects and properties we observe. These, though grouped and held together by their powers, do not touch each other, but have intervening space, otherwise pressure, or cold, could not make a body contract into a smaller bulk, nor heat, or tension, make it larger; in liquids these atoms, or particles, are free to move about one another, and in vapors, or gases, they are also present, but removed very much further apart, though still related to each other by their powers.

The atomic doctrine is greatly used one way or another in this, our day, for the interpretation of phenomena, especially those of crystallography and chemistry, and is not so carefully distinguished from the facts, but that it often appears to him who stands in the position of student, as a statement of the facts themselves, though it is at best but an assumption; of the truth of which we can assert nothing, whatever we may say, or think, of its probability. The word atom, which can never be used without involving much that is purely hypothetical, is often *intended* to be used to express a simple fact, but, good as the intention is, I have not yet found a mind that did habitually separate it from its accompanying temptations; and there can be no doubt that the words definite proportions, equivalents, primes, &c., which did and do express fully all the *facts* of what is usually called the atomic theory in chemistry, were dismissed because they were not expressive enough, and did not say all that was in the mind of him who used the word atom in their stead; they did not express the hypothesis as well as the fact.

But it is always safe and philosophic to distinguish, as much as is in our power, fact from theory; the experience of past ages is sufficient to show us the wisdom of such a course; and, considering the constant tendency of the mind to rest on an assumption, and, when it answers every present purpose, to forget that it is an assumption, we ought to remember that it, in such cases, becomes a prejudice, and inevitably interferes, more, or less, with a clear sighted judgment. I cannot doubt but that he who, as a mere philosopher, has most power of penetrating the secrets of nature, and guessing by hypothesis at her mode of working, will also be most careful, for his own safe progress, and that of others, to distinguish that knowledge which consists of assumption, by which I mean theory and hypothesis, from that which is the knowledge of facts and laws; never raising the former to the dignity, or authority, of the latter, nor confusing the latter, more than is inevitable, with the former.

Light and electricity are two great and searching investigators of the molecular structure of bodies, and it was whilst considering the probable nature of conduction and insulation in bodies not decomposable by the electricity to which they were subject, and the relation of electricity to space contemplated as void of that which by the atomists is called matter, that considerations something like those which follow were presented to my mind.

If the view of the constitution of matter, already referred to, be assumed to be correct, and I may be allowed to speak of the particles of matter, and of the space between them, (in water, or in the vapor of water, for instance,) as two different things, then space must be taken as the only continuous part, for the particles are considered as separated by space from each other. Space will permeate all masses of matter in every direction like a net, except that in place of meshes it will form cells, isolating each atom from its neighbors, and itself only being continuous.

Then take the case of a piece of shellac, a non-conductor, and it would appear at once from such a view of its atomic constitution,

that space is an insulator, for if it were a conductor the shellac could not insulate, whatever might be the relation as to conducting power of its material atoms; the space would be like a fine metallic web penetrating it in every direction, just as we may imagine of a heap of siliceous sand, having all its pores filled with water; or, as we may consider, of a stick of black wax, which, though it contains an infinity of particles of conducting charcoal diffused through every part of it, cannot conduct, because a non-conducting body (a resin) intervenes, and separates them one from another, like the supposed space in the shellac.

Next take the case of a metal, platinum, or potassium, constituted, according to the atomic theory, in the same manner. The metal is a conductor; but how can this be, except space be a conductor? for it is the only continuous part of the metal, and the atoms not only do not touch, (by the theory) but, as we shall see presently, must be assumed to be a considerable way apart. Space, therefore, must be a conductor, or else the metals could not conduct, but would be in the situation of the black sealing wax referred to a little while ago.

But if space be a conductor, how then can shellac, sulphur, &c., insulate? for space permeates them in every direction. Or if space be an insulator, how can a metal, or other similar body conduct?

It would seem, therefore, that in accepting the ordinary atomic theory, space may be proved to be a non-conductor in non-conducting bodies, and a conductor in conducting bodies, but the reasoning ends in this, a subversion of that theory altogether; for if space be an insulator it cannot exist in conducting bodies, and if it be a conductor it cannot exist in insulating bodies. Any ground of reasoning which tends to such conclusions as these, must, in itself, be false.

In connexion with such conclusions we may consider shortly what are the probabilities that present themselves to the mind, if the extension of the atomic theory which chemists have imagined, be applied in conjunction with the conducting powers of metals. If the specific gravity of the metals be divided by the atomic numbers, it gives us the number of atoms, upon the hypothesis, in equal bulks of the metals. In the following table the first column of figures expresses nearly the number of atoms in, and the second column of figures the conducting power of, equal volumes of the metals named:—

Atoms.		Conducting Power.
1.00	gold	6.00
1.00	silver	4.66
1.12	lead	0.52
1.30	tin	1.00
2.20	platinum	1.04
2.27	zinc	1.80
2.87	copper	6.33
2.90	iron	1.00

So here iron, which contains the greatest number of atoms in a given bulk, is the worst conductor excepting one. Gold, which contains the fewest, is nearly the best conductor; not that these conditions

are in inverse proportions, for copper, which contains nearly as many atoms as iron, conducts better still than gold, and with above six times the power of iron. Lead, which contains more atoms than gold, has only about one-twelfth of its conducting power; lead, which is much heavier than tin, and much lighter than platina, has only half the conducting power of either of these metals. And all this happens amongst substances which we are bound to consider, at present, as elementary, or simple. Whichever way we consider the particles of matter, and the space between them, and examine the assumed constitution of matter by this table, the results are full of perplexity.

Now let us take the case of potassium, a compact metallic substance with excellent conducting powers, its oxide, or hydrate, a non-conductor; it will supply us with some facts having very important bearings on the assumed atomic construction of matter.

When potassium is oxidized an atom of it combines with an atom of oxygen to form an atom of potassa, and an atom of potassa combines with an atom of water, consisting of two atoms of oxygen and hydrogen, to form an atom of hydrate of potassa, so that an atom of hydrate of potassa contains four elementary atoms. The specific gravity of potassium is 0.865, and its atomic weight 40; the specific gravity of cast hydrate of potassa, in such state of purity as I could obtain it, I found to be nearly 2, its atomic weight 57. From these, which may be taken as facts, the following strange conclusions flow. A piece of potassium contains less potassium than an equal piece of the potash formed by it and oxygen. We may cast into potassium oxygen atom for atom, and then again both oxygen and hydrogen in a two fold number of atoms, and yet, with all these additions, the matter shall become less and less, until it is not two-thirds of its original volume. If a given bulk of potassium contains 45 atoms, the same bulk of hydrate of potassa contains 70 atoms nearly *of the metal potassium*, and, besides that, 210 atoms more of oxygen and hydrogen. In dealing with assumptions I must assume a little more, for the sake of making any kind of statement; let me, therefore, assume that in the hydrate of potassa the atoms are all of one size, and nearly touching each other, and that in a cubic inch of that substance there are 2800 elementary atoms of potassium, oxygen, and hydrogen; take away 2100 atoms of oxygen and hydrogen, and the 700 atoms of potassium remaining will swell into more than a cubic inch and a half, and if we diminish the number until only those containable in a cubic inch remain, we shall have 430, or thereabout. So a space which can contain 2800 atoms, and amongst them 700 of potassium itself, is found to be entirely filled by 430 atoms of potassium as they exist in the ordinary state of that metal. Surely then, under the suppositions of the atomic theory, the atoms of potassium must be very far apart in the metal, *i. e.* there must be much more of space than of matter in that body: yet it is an excellent conductor, and so space must be a conductor; but then what becomes of shellac, sulphur, and all the insulators? for space must also, by the theory, exist in them.

Again, the volume which will contain 430 atoms of potassium, and

nothing else, whilst in the state of metal, will, when that potassium is converted into nitre, contain very nearly the same number of atoms of potassium, *i. e.* 416, and also then seven times as many, or 2912 atoms of nitrogen and oxygen besides. In carbonate of potassa the space which will contain only the 430 atoms of potassium as metal, being entirely filled by it, will, after the conversion, contain 256 atoms more of potassium, making 686 atoms of that metal, and, in addition, 2744 atoms of oxygen and carbon.

These and similar considerations might be extended through compounds of sodium, and other bodies, with results equally striking, and, indeed, still more so, when the relations of one substance, as oxygen, or sulphur, with different bodies, are brought into comparison.

I am not ignorant that the mind is most powerfully drawn by the phenomena of crystalization, chemistry, and physics, generally, to the acknowledgment of centres of force. I feel myself constrained, for the present, hypothetically, to admit them, and cannot do without them, but I feel great difficulty in the conception of atoms of matter, which, in solids, fluids, and vapors, are supposed to be more, or less, apart from each other, with intervening space not occupied by atoms, and perceive great contradictions in the conclusions which flow from such a view.

If we must assume at all, as indeed in a branch of knowledge like the present we can hardly help it, then the safest course appears to be to assume as little as possible, and in that respect the atoms of Boscovich appear to me to have a great advantage over the more usual notion. His atoms, if I understand aright, are mere centres of forces, or powers, not particles of matter, in which the powers themselves reside. If, in the ordinary view of atoms, we call the particle of matter away from the powers a, and the system of powers, or forces, in and around it m, then in Boscovich's theory, a disappears, or is a mere mathematical point, whilst, in the usual notion, it is a little unchangeable, impenetrable piece of matter, and m is an atmosphere of force grouped around it.

In many of the hypothetical uses made of atoms, as in crystalography, chemistry, magnetism, &c., this difference in the assumption makes little or no alteration in the results, but in other cases, as of electric conduction, the nature of light, the manner in which bodies combine to produce compounds, the effects of forces, as heat, or electricity, upon matter, the difference will be very great.

Thus, referring back to potassium, in which as a metal the atoms must, as we have seen, be, according to the usual view, very far apart from each other, how can we for a moment imagine that its conducting property belongs to it, any otherwise than as a consequence of the properties of the space, or, as I have called it above, the m? so also its other properties in regard to light, or magnetism, or solidity, or hardness, or specific gravity, must belong to it, in consequence of the properties, or forces, of the m, not those of the a, which, without the forces, is conceived of as having no powers. But then surely the m is the *matter* of the potassium, for where is there the least ground,

(except in a gratuitous assumption) for imagining a difference in kind between the nature of that space midway between the centres of two contiguous atoms, and any other spot between these centres? a difference in degree, or even in the nature of the power consistent with the law of continuity, I can admit, but the difference between a supposed little hard particle, and the powers around it, I cannot imagine.

To my mind, therefore, the *a*, or nucleus, vanishes, and the substance consists of the powers, or *m;* and, indeed, what notion can we form of the nucleus independent of its powers? all our perception and knowledge of the atom, and even our fancy, is limited to ideas of its powers: what thought remains on which to hang the imagination of an *a*, independent of the acknowledged forces? A mind just entering on the subject, may consider it difficult to think of the powers of matter independent of a separate something to be called *the matter*, but it is certainly far more difficult, and indeed impossible, to think of, or imagine, that *matter* independent of the powers. Now the powers we know and recognize in every phenomena of the creation, the abstract matter in none; why then assume the existence of that of which we are ignorant, which we cannot conceive, and for which there is no philosophical necessity?

Before concluding these speculations I will refer to a few of the important differences between the assumption of atoms consisting merely of centres of force, like those of Boscovich, and that other assumption of molecules of something specially material, having powers attached in and around them.

With the latter atoms, a mass of matter consists of atoms and intervening space; with the former atoms, matter is everywhere present, and there is no intervening space unoccupied by it. In gases the atoms touch each other just as truly as in solids. In this respect the atoms of water touch each other whether that substance be in the form of ice, water, or steam; no mere intervening space is present. Doubtless the centres of force vary in their distance one from another, but that which is truly the matter of one atom touches the matter of its neighbors.

Hence matter will be *continuous* throughout, and in considering a mass of it we have not to suppose a distinction between its atoms, and any intervening space. The powers around the centres give these centres the properties of atoms of matter; and these powers again, when many centres by their conjoint forces are grouped into a mass, give to every part of that mass the properties of matter. In such a view all the contradiction resulting from the consideration of electric insulation and conduction disappears.

The atoms may be conceived of as highly *elastic*, instead of being supposed excessively hard and unalterable in form; the mere compression of a bladder of air between the hands can alter their size a little; and the experiments of Cagniard de la Tour carry on this change in size until the difference in bulk at one time and another may be made several hundred times. Such is also the case when a solid, or a fluid, body is converted into vapor.

With regard also to the *shape* of the atoms, and, according to the

ordinary assumption, its definite and unalterable character, another view must now be taken of it. An atom by itself might be conceived of as spherical, or spheroidal, or where many were touching in all directions, the form might be thought of, as a dodecahedron, for any one would be surrounded by, and bear against, twelve others, on different sides. But if an atom be conceived to be a centre of power, that which is ordinarily referred to under the term *shape*, would now be referred to the disposition and relative intensity of the forces. The power arranged in and around a centre might be uniform in arrangement and intensity in every direction outwards from that centre, and then a section of equal intensity of force through the radii would be a sphere; or the law of decrease of force from the centre outwards might vary in different directions, and then the section of equal intensity might be an oblate, or oblong, spheroid, or have other forms; or the forces might be disposed so as to make the atom polar; or they might circulate around it equatorially, or otherwise, after the manner of imagined magnetic atoms. In fact nothing can be supposed of the disposition of forces in, or about, a solid nucleus of matter, which cannot be equally conceived with respect to a centre.

In the view of matter now sustained as the lesser assumption, matter and the atoms of matter would be mutually penetrable. As regards the mutual penetrability of matter, one would think that the facts respecting potassium and its compounds, already described, would be enough to prove that point to a mind which accepts a fact for a fact, and is not obstructed in its judgment by preconceived notions. With respect to the mutual penetrability of the atoms, it seems to me to present, in many points of view, a more beautiful, yet equally probable and philosophic idea of the constitution of bodies than the other hypotheses, especially in the case of chemical combination. If we suppose an atom of oxygen, and an atom of potassium about to combine and produce potash, the hypothesis of solid, unchangeable, impenetrable atoms places these two particles side by side in a position, easily, because mechanically, imagined, and not unfrequently represented; but if these two atoms be centres of power they will mutually penetrate to the very centres, thus forming one atom, or molecule, with powers, either uniformly around it, or arranged as the resultant of the powers of the two constituent atoms; and the manner in which two, or many, centres of force may in this way combine, and afterwards, under the dominion of stronger forces, separate again, may, in some degree, be illustrated by the beautiful case of the conjunction of two sea waves of different velocities into one, their perfect union for a time, and final separation into the constituent waves, considered, I think, at the meeting of the British Association at Liverpool. It does not, of course, follow, from this view, that the centres shall always coincide; that will depend upon the relative disposition of the powers of each atom.

The view now stated of the constitution of matter would seem to involve, necessarily, the conclusion that matter fills all space, or, at least, all space to which gravitation extends, including the sun and its system; for gravitation is a property of matter dependent on a certain

force, and it is this force which constitutes the matter. In that view matter is not merely mutually penetrable, but each atom extends, so to say, throughout the whole of the solar system, yet always retaining its own centre of force. This, at first sight, seems to fall in very harmoniously with Mossotti's mathematical investigations, and reference of the phenomena of electricity, cohesion, gravitation, &c., to one force in matter; and also again with the old adage, "matter cannot act where it is not." But it is no part of my intention to enter into such considerations as these, or what the bearings of this hypothesis would be on the theory of light, and the supposed ether. My desire has been rather to bring certain facts from electrical conduction and chemical combination to bear strongly upon our views regarding the nature of atoms and matter, and so to assist in distinguishing in natural philosophy our real knowledge, *i. e.* the knowledge of facts and laws, from that, which, though it has the form of knowledge, may, from its including so much that is mere assumption, be the very reverse.

Royal Institution, January 25th, 1844.

Lond. Edin. and Dub. Philos. Mag.

Coal Formation of Nova Scotia. From ABRAHAM GESNER'S *Memoir on the Geology of Novia Scotia.*

Unless the calcareous deposits of the districts of Pictou and Stewiack should be found to belong to the carboniferous limestone of New Brunswick and Great Britain, the author is not aware that there are any beds in the province which are referable to that formation. The coal field which skirts nearly the whole of the northern coast of Nova Scotia, and which occupies the greater part of the isthmus, is a small part of that extensive coal field of which the remainder is situated in the province of New Brunswick. In Nova Scotia, the commencement of the coal field towards the east is near Pomket Harbor, between the 45th and 46th parallels of north latitude, and the 61st and 62nd meridians of west longitude. Hence it extends along the whole northern coast of the province of Nova Scotia to Bay Verte, where it enters the province of New Brunswick. The area of the coal field in Nova Scotia is about 2500 square miles, and that of the coal field in New Brunswick about 7500 square miles, making the total area of the coal field in the two provinces 10,000 square miles, and in this computation is not included the coal field of Cape Breton. The above coal field may, therefore, be considered as one of the most extensive on the face of the globe, and as of great value to Great Britain, and her North American colonies. The strata occupying this extensive area consist

1. Of gray, red, and chocolate colored sandstones and conglomerates;
2. Of red, blue, and black shales;
3. Of shelly lime stones;
4. Of clay iron stone;

5. Of coal, of which the bituminous variety occurs throughout the district.

All the strata abound in the remains of the plants that are usually found in the coal measures.

The coal measures usually lie in long parallel troughs, or in circular basins, towards the bottoms of which troughs, or basins, the strata dip in opposite directions. The prevailing strike of the strata is from south-west to north-east, which is also that of the more ancient slate rocks of Nova Scotia. The dip of the coal measures varies from 5° to 45°. Throughout the whole of the coast line, from Pomket Harbor to Point Miscou, the coal measures undergo scarcely any fault, or dislocation.

From Pictou Harbor, in Northumberland Strait, a belt of coal measures, about six miles broad, runs in a westerly direction across the isthmus, passing between the southern flank of the Cobequial mountains, and the southern coast of the isthmus, along the Basin of Mines, and thence running further westward to Advocate Harbor. The length of this belt is about 100 miles; the strata which compose it rest along the northern margin of the great part of the belt, on the fossiliferous slates of the Cobequial mountain ; it is along its southern margin, that at Moose River and Advocate Harbor, the coal strata rest unconformably on old red sand stone. At Moose River the coal measures contain a thin bed of marine lime stone, and like the old red sand stone which they rest upon, thin beds of gypsum. The coal measures lap round the eastern extremity, and pass along the northern flank of the fossiliferous slates of the Cobequial range ; whence they pass nearly due west to Apple River, on Chignecto Bay. All the isthmus north of this line consists of coal measures.

The Nova Scotian, or south-eastern coast of Chignecto Bay, runs nearly at right angles to the direction of the coal strata, and presents an admirable section of them nearly thirty-five miles in length. Along this length of coast the strata lie in a trough, the base, or synclinal, point, of which is Little Shoolie; and from this point, as you recede further in a north-eastern direction, the strata rise to the north and north-north-west, with an increasing dip. At the Joggins, twelve miles north-east of Little Shoolie, where the blue sand stone is extensively worked for grind-stones, the dip is from 25° to 35°. In the opposite direction, as you recede from the base of the trough, the strata rise towards the south, until on approaching the intrusive rocks of Cape Chignecto the inclination is 45°.

In making a careful examination of the entire of this coast of thirty-five miles, only one fault was observed, and that occasioned a dislocation of only a few feet. By measuring the horizontal distances between the strata, and making allowance for their inclination at a number of places, the author estimated the total thickness of the coal measures on this coast at not less than three miles.

The chief part of the workable seams of coal is probably exposed on the Chignecto shore, and it is near the middle of the section that most coal seams are seen. At the South Joggins, in the above coast section, in the horizontal distance of three quarters of a mile, and in

a thickness of strata amounting to 1800 feet, nineteen seams of coal are seen, from six inches to four feet thick. Outcrops of coal have been observed to the south-west of the Joggins, on the Apple River, and to the north-east on the river Hebert; also on the Macan river, where one seam is ten feet thick, and of good quality; and also near the river Philip. In the eastern part of the northern coast of the province coal first appears at Pomket; then at Fraser's mountain, and at the Albion mines, and other places near Pictou. In the belt of coal measures which lies south of the Cobequial mountain, two seams of coal have been discovered in the forest, ten miles north of Truro, dipping from that range. Outcrops of coal appear also in the same belt at Jolly river, at Debert river, at Economy river, and at Parr's Borough.

Along the northern coast which borders on Northumberland Strait, and along the courses of the rivers which fall into that Strait, coal plants are very abundant. Among these are many large trees which were branching at their tops. The bark is generally converted into coal, and sometimes the whole trunk; and then the woody fibre remains very distinct. Several of these trees are four feet in diameter, and some have been seen six feet in length. Along this coast the trees are all prostrate, whether in the sand stones, or shales, and they do not appear to lie more in one direction than another. On the coast of Chignecto Bay, fossil trees also abound; and in most places they lie in all positions, parallel to the strata, or across them obliquely. They always increase in number in the proximity of a seam of coal. In one part, however, of the Chignecto coast, called South Joggins, where the nineteen seams of coal, already mentioned, occur for the space of three-quarters of a mile, and in a thickness of strata amounting to 1800 feet, the fossil trees which occur are all perpendicular to the strata. In tracing these seams of coal along the ravines to the distance of six miles from the coast, trees have been observed in the same vertical position in respect of the strata. The cliffs at this spot are from 80 to 100 feet in height, and consist of gray and reddish sand stone, bituminous blue shale, shelly lime stone, clay iron stone, and coal. The strata are rapidly degraded, so that at every successive visit which the author has made to the spot, during the last ten years, he found that trees which he had originally observed had disappeared, and that others were exposed in their steed. At the last visit he made, which was in July last, in company with Mr. Lyell, seventeen trees were exposed to view, and this number was rather less than he had seen on former occasions. The ordinary length of these trunks is from 10 to 30 feet, but some have been observed that were 50, or even 70, feet long. They vary in diameter from 6 inches to 3 feet; but one was 4 feet 6 inches across. Most frequently their lower extremities are situated in shale; but sometimes they spring from the coal itself, and when that is the case, they never pass through the seam of coal. Sometimes their roots branch out into the shale, or sand stone, they rest upon.

At the place above referred to, ten miles north of Truro, the strata above and below the coal abound in trunks, branches, and leaves of

large fossil trees. The exterior of the trunks is coal; and the interior is usually sand stone and fine clay. In one tree the whole trunk was coal, except a flattened portion resembling the pith, and extending through the centre of the tree from one extremity to the other. At the spot on the Moose river, where the coal measures rest on old red sand stone, a fossil tree 30 inches in diameter, is seen in black shale, and dark colored sand stone.

Besides the coal district, already described, there is an area near Falmouth and Windsor, of seventy square miles, in which, though the coal has not been discovered, yet the ferns, *Stigmaria*, and other fossil plants which the sand stones and shales of that area contain, sufficiently establish the point that it belongs to the coal measures. Ibid.

Electro-Metallurgy. Historical and Practical Notices of the Art.

It is remarkable that chemistry has rarely presented society with a discovery of importance in the practical arts, which has not been more the result of accidental observation—of unexpected fact, eliminated in the course of investigations undertaken for objects of a different nature—than of direct inquiry, instituted for the purpose of arriving at the discovery. This, indeed, is to be expected. Chemistry, unlike mathematics, is not a science of reasoning; it is a science of observation and deduction, founded upon experiment. The history of the accidental discoveries which have been made in it, would, in effect, be a history of at least the early part of the science; and of the whole round of the chemical arts and manufactures. In the mean time, we confine our attention to one of its later bequests—to electro-metallurgy, which has already found extensive application in the hands of the practical man, and which, in point of history, affords a remarkable confirmation of the doctrine that no scientific fact is without its value.

Ever since the discovery, by Volta, of the voltaic pile—which is simply a multiplication of zinc and silver plates, separated by pieces of paper, or cloth, moistened in some saline, or dilute, acid solution—the attention of electro-chemists has been occupied with attempts to determine the arrangement best suited to produce, not only the most powerful, but likewise the most constant, current of electricity by chemical means. The different modifications proposed, are nearly as numerous as the experimenters; but although the results are to this extent unsatisfactory, we are indebted to the investigations, undertaken with a view to the establishment of accurate data of arrangement, for many interesting, and, at the same time, practically useful discoveries, altogether apart from the direct object of inquiry. None of the least of these, is the art of electro-metallurgy, which, notwithstanding its being a very recent addition to our practical knowledge, is familiar, at least in name, to every scientific reader. It has also its literature; but the treatises which have hitherto been given to the

public, although they contain much valuable information respecting its principles, leave us much room for a few practical papers, in which we intend to treat the subject more as an art than a philosophical question. It is not, however, our intention to avoid the discussion of its principles. On the contrary, while we are practical, we shall not overlook theory, on which all practice must be founded; and, in order that we may bring the *modus operandi* of the art fully before the reader, we think it expedient, in the first place, to give a concise statement of the fundamental principles upon which the art depends.

If a piece of metallic zinc be taken, and immersed in water acidulated with sulphuric, or muriatic, acid, the zinc is speedily dissolved; hydrogen gas is, at the same time, evolved from the decomposition of the water. This gas has a pungent smell, from the impurities in the metals employed. If pure metals were employed, this action of the acid would not proceed; but as pure metal cannot be obtained for ordinary use, the same effects in voltaic operations may be obtained, by taking the common zinc of commerce, after the acid has begun to act upon it, and rubbing a little mercury over its surfaces with a soft brush—the mercury combines with the zinc, and forms what is termed an amalgam upon its surface—or, in common language, the zinc plate is amalgamated.

If this amalgamated zinc be now put into the dilute acid, no action will be observed; if into the same acid solution be put a piece of clean copper, provided the metals do not touch, no more action is observed than if they were placed in as much water. But if we allow the copper and zinc to touch one another, either by the portions immersed, or out of the acid, hydrogen will be evolved from the surface of the copper, and that metal will appear being dissolved; but if the action be allowed to proceed for a short time, it will be observed from the corrosion of the zinc, that it is that metal, and not the copper, that is being dissolved. If, instead of causing the two metals to touch each other, they be connected by a very fine platinum, or steel, wire, this wire will become red hot from some "substance,' "agency," or "influence," which is passing from the copper through it to the zinc. This something is *electricity:* it is an electric current which has, in the first instance, been generated by the action of the solution upon the zinc; and, having passed through the solution to the copper, passes from thence through the wire to the zinc again. These two metals, thus arranged with the acid, constitute a galvanic battery of a single pair.

It was soon found by experience, that this kind of battery neither gives a long continued, nor a constant, current of electricity, from the following causes:—first, the hydrogen is not freely evolved from the surface of the copper plate; and, consequently, obstructing the influence of surface, affects materially the quantity of electricity obtained; and, secondly, a portion of the oxide, or chloride, of zinc, formed by the action of the acid upon the amalgamated zinc, being reduced and carried along with the hydrogen to the copper plate upon which it is deposited, forms a zinc surface upon the copper, which tends to transmit a current of electricity in the contrary direction; and, conse-

quently, to neutralize to some extent the original power of the circle. A few years ago, these disadvantages were, to a great extent, overcome by a very ingenious arrangement, discovered by Professor Daniell. The discovery consists in the separation of the zinc from the copper by a porous diaphragm; the portion containing the zinc is charged with dilute acid as before, but the portion containing the copper is filled with a solution of sulphate of copper. The action in this battery is similar to that described above; the zinc is dissolved by the acid, but the hydrogen, instead of being evolved at the copper plate, combines with the acid of the sulphate of copper; the metallic copper is thus set at liberty, and combines with the copper plate, not only maintaining, but improving its surface, during the evolution of a constant current of electricity. During experiments with this form of battery, Professor Daniell observed, that the copper deposited, when separated from the plate, contained inverse impressions of scratches which had been previously upon the plate; but the object of the experimenter had been fully attained, namely, the construction of a constant battery,* and the practical applications of the phenomenon of deposition were overlooked.

At this point the matter rested for several years, till towards 1838, when Mr. Thomas Spencer, of Liverpool, by a series of accidental circumstances, was led to think of the application of the decomposition of the copper, by electric action, to the multiplication of works of art—principally at first with a view to the formation of designs upon copper plates for printing—an idea from which has sprung the beautiful art of glyphography.

The following paragraph from Mr. Spencer's paper, read before the Liverpool Polytechnic Institution, announcing the discovery, will convey some notion of the seemingly trifling circumstance from which has sprung the art of electrotyping:—

"The members of the Society will recollect that, on the first evening it met, I read a paper upon the production of metallic veins in the crust of the earth, and that, among other specimens of cupreous crystalization which I produced on that occasion, I exhibited three coins—one wholly covered with metallic crystals, the others on one side only. It was used under the following circumstances:—When about to make the experiment, I had not a slip of copper at hand to form the negative end of my own arrangement; and, as a good substitute, I took a penny, and fastened it to one end of the wire, and put it in connexion with a piece of zinc, in the apparatus described, (a Daniell's battery.) Voltaic action took place, and the copper coin became covered with a deposition of metal in a crystaline form. But when about to make another experiment, and being desirous of using the piece of wire, used in the first instance, I pulled it off from the coin to which it was attached. In doing this, a piece of the deposited copper came off with it, and on examining the under portion, I found it contained an exact mould of a part of the head and letters of the coin, as smooth and sharp as the original on which it was deposited." This may be considered the history of the first electrotype, but still from the deposited metal being brittle, and other circumstances which

* A practical description of this battery will be given under the proper head.

probably had too much weight with Mr. Spencer, this electrotype, which ought to have been placed in the British Museum, was laid aside. Some time after this, Mr. Spencer accidentally dropping a little varnish upon a slip of copper upon which he was about to deposit, found that the deposit might be guided by such non-conducting substances over the surface; and finding also, by experience, that deposited metal is not necessarily brittle, but has its tenacity regulated by the electro current, thought of repeating the experiment with a coin in the same manner, that gave him the results just detailed. The result of this trial was a perfect electrotype. Being once successful, Mr. Spencer followed up his discovery with much vigor, surmounting many difficulties, and succeeded so far as to be able, in a short time, to furnish some excellent processes, by which medals and plates may be copied, and also means by which non-conducting substances, such as wood, wax, plaster, and the like materials, might also be coated.

We may mention here, that during the same time that Spencer was maturing his discovery, so as to bring it before the public, Professor Jacobi, of St. Petersburgh, announced a similar discovery; and, as in many other instances, the merit of the first discovery of this art, has, consequently, become a matter of dispute—both claiming precedence. From the evidence brought forward on the different sides, it would be a matter of some difficulty to decide to whom it most justly belongs.

The publication of Mr. Spencer's discovery acted like an electric shock upon society, and men, both of science and art, became active competitors in this new field of application; the one class anxious to bear away the honors arising from some important improvement—the other, the profits which might follow some novel application of the process to their own, or some other, branch of manufacture. With these combined efforts, it need not be wondered at, that in a very short time improvements of great scientific interest were pointed out, and applications of the greatest importance to the arts and manufactures of this country were introduced. In consequence, some of our old and standard manufactures, as we shall subsequently have occasion to notice at some length, have already begun to be revolutionized.

It may be necessary, in this historical sketch, to remark briefly those improvements which were introduced into electro-metallurgy by men of science. In general terms, these may be ranked under three heads: the first was the use of plumbago, or black lead, to give the surface of non-metallic bodies a conducting medium. This was the discovery of Mr. Murray, a gentleman of high attainments, and unassuming manner, who communicated the process to the members of the Royal Institution, orally. The Society of Arts afterwards awarded to Mr. Murray a silver medal, as an expression of their sense of the value of the discovery. This application at once freed electro-metallurgy from every bound; it was no longer necessary to use either metallic moulds, or moulds having metal reduced upon their surfaces by chemical means—which, according to the processes then known, was both a tedious and uncertain operation, and only

applicable to certain substances. Plumbago possessed all the requisite properties; it was plentiful, and, therefore, cheap; easily applied, and equally effective for every substance on which the electrotypist desired to obtain a deposit, or which he could wish to cover with metal, either for useful, or ornamental, purposes.

The next improvement of much importance was made by Mr. Mason, and consisted in the application of a separate battery. Previous to this discovery, what is termed the single cell process, was the only one used. It consisted in simply attaching the article to be deposited upon by a wire to a piece of zinc, and immersing the one into dilute acid, and the other into a solution of the metal to be deposited. The two liquids being divided by a porous diaphragm, constituted, as has already been observed, a battery of a single cell; but in this case, the whole electricity was expended within the cell to deposit the metal upon the mould. By Mr. Mason's discovery, the electricity generated in the cell could be made to do an equivalent of work in a separate cell as well,—making the original arrangement the generating cell, or battery, to the second cell. In this last was also a solution of a metal having in it a sheet of similar metal attached to the copper of the first, and the mould to be covered attached to the zinc of the first.

This process, with different forms of battery, will be described in detail in another part of these papers. It may, however, in the mean time be remarked, that many improvements of a minor kind followed those enumerated; but the last, and probably the most important in a manufacturing point of view, was introduced by Mr. Parkes, of Birmingham, to whom electro-metallurgists are much indebted. Instead of using plumbago, which, for large surfaces, has many objections, he takes wax, or better, a mixture of wax and rosin, or such other mixture as may be preferred for moulds, and mixes with it a solution of phosphorous in sulphuret of carbon—about one ounce of the former to four of the latter. He then takes a solution of nitrate of silver, about one ounce of this salt to four gallons of water. After the mould is obtained, it is put into this solution of nitrate of silver, (lunar caustic) and in a few minutes a thin film of silver is reduced upon its surface. The mould is then attached to the battery, and immersed in the copper solution; the deposit over every part of its surface is instantaneous, and does not grow over it, as is the case with plumbago. For coppering plastic terra cotta, wood, shells, flowers, leaves, and the like, the solution of phosphorous in sulphuret of carbon is admirably adapted. The article to be coated requires merely to be washed over with this solution, and immersed in the nitrate of silver solution; a thin film of the silver is immediately reduced upon its surface, and it is then ready to be put into the copper solution. We must, however, defer the more minute details, until we come to speak of the art of producing electrotypes.

The improvements here enumerated in connexion with the general law first pointed out by Mr. Spencer, and more fully developed and explained by Mr. Smee, and other experimenters, and which will be described in order—constitute the art of electro-metallurgy.

As might have been expected, during the general excitement which prevailed at the commencement of electro-metallurgy, each aspirant being actuated by different motives, viewed results in different lights. All the new results obtained, although isolated, were, in the hands of so many experimenters, soon reduced to a systematic whole. Honesty, we are sorry to add, did not uniformly characterize the progress of the art. The history, short as it is, is not wanting in instances of unjust appropriation of discoveries; or, viewing the progress of events in another light, we have instances of individuals becoming so engrossed with their own investigations, as to overlook the labors of others;—hurrying over a series of experiments they write a history of the art, and lay claim to a goodly share of the discoveries. As an example, we quote the following from a host of others:—

"The laws regulating the reduction of all metals in different states, were first given in this work as the result of my own discoveries. By these we can *throw* down gold, silver, platinum, palladium, copper, iron, and almost all other metals in three states, namely, as a black powder, as a crystaline deposit, or as a flexible plate. These laws appear to me at once to raise the isolated facts known as the electrotype into a science, and to add electro-metallurgy as an auxiliary to the noble arts of this country."—*Smee's Electro-Metallurgy.*

These are broad claims, and as broadly asserted; but, happening to know somewhat intimately the history of electro-metallurgy, and to have read a certain fable about a crow in peacock-dress, we are naturally led to inquire into the magnitude of Mr. Smee's claims to our gratitude a little more particularly—not for the purpose of detracting from the merits of any individual who labors to advance the cause of science, but with the honest intent of giving to all their due rights; knowing also, that if such statements as contained in the paragraph quoted, were well founded, it did not require the author to enumerate his claims so prominently. We think it no digression in a historical sketch, to trace how far these pretensions are just. The first in order, is the laws regulating the reduction of all metals.

"Law I.—The metals are invariably thrown down as a black powder, when the current of electricity is so strong, in relation to the strength of the solution, that hydrogen is evolved from the negative plate of the decomposition cell.

"Law II.—Every metal is thrown down in a crystaline state, when there is no evolution of gas from the negative plate, or no tendency thereto.

"Law III.—Metals are reduced in the reguline state, when the quantity of electricity, in relation to the strength of the solution, is insufficient to cause the production of hydrogen in the negative plate in the decomposition trough, and yet the quantity of electricity very nearly suffices to induce that phenomenon."

We will not here inquire whether these laws are strictly correct, as we will have occasion to examine the subject at length, in one of our forth-coming papers, but will, in the mean time, simply see what Mr. Spencer says of these laws. In his original paper announcing

the discovery, eighteen months previous to the publication of Mr. Smee's work, there is the following paragraph:—

"I discovered that the solidity of the metallic deposition depended entirely on the weakness, or intensity, of the electro-chemical action, which I knew I had in my power to regulate at pleasure, by the thickness of the intervening wall of plaster of Paris, and by the coarseness, or fineness, of the material. I made three similar experiments, altering the texture and thickness each time, by which I ascertained, that if the partitions were *thin* and *coarse*, the metallic deposition proceeded with great *rapidity*, but the crystals were friable and easily separated; on the other hand, if I made them thicker, and of a little finer material, the action was slower, but the metallic deposition was as solid and ductile as copper formed by the usual methods. Indeed, when the action was exceedingly slow, I have had a metallic deposition much harder than common sheet copper, but more brittle."

The identity of these laws requires no comment; and, comparing the circumstances of the one having nothing but the rude apparatus of a new born art suggested by himself, to that of the other, enjoying the advantages of eighteen months' improvements, Mr. Spencer is astonishingly correct.

The other claim in the paragraph, is being the father of the science of electro-metallurgy, and adding this science to the noble arts of this country. Unfortunately for the validity of this claim, patents had been previously taken out, both in this country and in France, for the application of it to the arts. Messrs. Elkington's patent for the application of the science to silvering and gilding—the most extensive application yet introduced—was published in full detail, and the manufacture was in extensive operation months before the publication of Mr. Smee's book.

We will not notice more of Mr. Smee's claims to discovery in this part of these papers, but must add, that the publication of his book gave an impulse to the study of electro-metallurgy; it is not only a goodly collection of the loose facts scattered throughout various periodicals, but contains besides a digest of a host of experiments made by himself, and these are very carefully and correctly detailed.

We may also observe, that a few months after the publication of Mr. Smee's work, Mr. Walker published a little manual upon electrotype manipulation, which, from its popular style and cheapness, did more to spread a knowledge of the art, and to attract the attention of all classes to it, than all the other publications put together.

In our next article we will describe what we have found in practice to be the best battery arrangement, and the method of proceeding to practice the art of electrotyping, both on a large and small scale. We will then proceed to the practical details of gilding and plating different metals by the electro process, as practiced by the different manufacturers engaged in the art throughout England and France.

Glasgow Mech. & Eng. Mag.

To be Continued.

On the manner in which Cotton unites with Coloring Matter. By WALTER CRUM, Esq., *Vice President of the Philosophical Society of Glasgow.**

The effect of porous bodies in producing combination and decomposition, independently of chemical affinity, has, of late years, occupied considerable attention.

If we examine, says Professor Mitscherlich, a piece of box-wood by the microscope, we find it composed of cells which have a diameter of about $\frac{1}{2400}$th of an inch. Heated to redness, the form of these cells suffers no change, for the particles of which it is composed have no tendency to run together in fusion. A cubic inch of box-wood charcoal boiled for some time in water, absorbed five-eighths of its volume of that liquid; from which, and other data, it was computed that the surface of its pores was 73 square feet.

Saussure observed that a cubic inch of box-wood charcoal absorbed 35 cubic inches of carbonic acid; and as the solid part of the charcoal formed three-eighths of its bulk, these 35 inches of gas must have been condensed into five-eighths of an inch, or 56 cubic inches into one, under the ordinary pressure of the atmosphere. But carbonic acid liquefies under a pressure of 36.7 atmospheres, and, therefore, with a power of condensation equal to 56 atmospheres, which the charcoal exerted in Saussure's experiment, at least one-third of the gas must have assumed the liquid state within its pores.

Every other porous body has the same property as charcoal. Raw silk, linen, thread, the dried woods of hazel and mulberry, though they condense but a small quantity of carbonic acid, take up from 70 to 100 times their bulk of ammoniacal gas; and Saxon hydrophane, which is nearly pure silica, absorbs 64 times its bulk. The gases enter into no combination with the solid which absorbs them, for the air-pump alone destroys their union

. The manner in which gases are attracted to the surfaces of solid bodies is very much like that which these exert on substances dissolved in water. The charcoal of bones has been long employed to remove coloring matter from the brown solution of tartaric acid, from sirop in the refining of sugar, and from a variety of other liquids containing organic substances; and it is found that the coloring matter so attracted remains attached to the surface of the charcoal without effecting any change upon it. In this animal charcoal the carbon is mixed with ten times its weight of phosphate of lime, and if that be washed away by an acid, the remaining charcoal has nearly twice the decolorating power of an equal weight of ivory-black. Bussy, who has made the action of these charcoals the subject of particular investigation, informs us that if ivory-black, after the extraction of its earth of bones by an acid, be calcined along with potash, and the potash be afterwards washed out, or if blood be at once calcined with carbonate of potash and washed, the remaining charcoal has the

* Read before the Philosophical Society of Glasgow, February 1, 1843; and communicated to this Journal by the author.

power of decolorating twenty times as much sirop as could be done by the original bone charcoal. Animal charcoal removes, also, lime from lime water, iodine from a solution of iodide of potassium, and metallic oxides from their solutions in ammonia and caustic potash.

A satisfactory explanation of these remarkable facts has yet to be sought for. Mitscherlich calls the force which produces them an action of contact, or attraction, of surface; and he calculates, as we have seen, the extent of surface in proportion to the mass as the measure of the force which it exerts. On the other hand, Saussure, in his valuable paper on the absorption of gases, informs us that charcoal from box-wood, in the solid state, absorbs twice as much common air as when it is reduced to powder. Now the effect of pulverization is certainly not to diminish the extent of surface. Saussure accounts for it in another way, and his explanation seems to connect many of the facts. The condensation of gases in solid charcoal goes on, he conceives, in the narrow cells of which it is composed, and is analogous to the rise of liquids in capillary tubes. In both, he says, the power appears to be in the inverse ratio of the size of the interior diameters of the pores, or tubes, of the absorbing bodies. When we pulverize a body containing such cells, we widen, open, and destroy them. Fir charcoal, whose cells are wide, absorbs 4½ times its bulk of common air, and box-wood charcoal with smaller pores takes 7½. Charcoal from cork, with a specific gravity of only 0.1, absorbs no appreciable quantity.

It appears to me that many of the operations of dyeing depend upon this influence of the surface, or the capillary action described by Saussure.

The microscopic examination of the fibres of cotton by Mr. Thomson, of Clitheroe, and Mr. Bauer, shows them to consist of transparent glassy tubes, which, when unripe, are cylindrical, and in the mature state collapsed in the middle, from end to end, giving the appearance of a separate tube on each side of the flattened fibre.

In many of the operations of dyeing and calico printing, the mineral basis of the color is applied to the cotton in a state of solution in a volatile acid. This solution is allowed to dry upon the cloth, and in a short time the salt is decomposed, just as it would be in similar circumstances without the intervention of cotton. During the decomposition of this salt its acid escapes, and the metallic oxide adheres to the fibre so firmly as to resist the action of water applied to it with some violence. In this way does acetate of alumine act, and nearly in the same manner acetate, of iron. The action here can only be mechanical on the part of the cotton, and the adherence, as I shall endeavor to show, confined to the interior of the tubes of which wool consists. The metallic oxide permeates these tubes in a state of solution, and it is only when its salt is there decomposed, and the oxide precipitated and reduced to an insoluble powder, that it is prevented from returning through the fine filter in which it is then inclosed.

When the piece of cotton, which, in this view, consists of bags lined inside with a metallic oxide, is subsequently dyed with madder,

or log-wood, and becomes thereby red, or black, the action is purely one of chemical attraction between the mineral in the cloth, and the organic matter in the dye vessel, which together form the red, or black, compound that results; and there is no peculiarity of a chemical nature from the mineral constituent being previously connected with the cotton. The process of cleansing in boiling liquids, and in the wash-wheel, to which cotton printed with the various mordants is subjected, previous to being maddered, is to remove those portions of metallic oxide which have been left outside the fibres, or got entangled between them, and fastened there more, or less, firmly, by the mucilage employed to thicken the solution.

The view I have now given, is, in some respects, the old mechanical theory of dyeing held by Macquer, Hellot, and Le Pileur d'Apligny before the time of Bergman. Although unacquainted with the microscopic appearance of cotton, d'Apligny argued that as no vegetable substance in its growth can receive a juice without vessels proper for its circulation, so the fibres of cotton must be hollow within. And of wool, he says, the sides of the tubes must be sieves throughout their length, with an infinity of lateral pores. We may gather also that he conceived dyeing to consist, first, in removing a medullary substance contained in the pores of the wool, and afterwards depositing in them particles of a foreign coloring matter.

But Bergman, in his Treatise on Indigo, in 1776, upset all this, and attributed to cotton a power of elective attraction, by which all the phenomena of dyeing were referred to purely chemical principles. Macquer soon adopted the chemical theory, and it was keenly advanced by Berthollet, who succeeded Dufay, Hellot, and Macquer, in the administration of the arts connected with chemistry. Berthollet has been followed by all, so far as I know, who have since that time written on the subject, but nothing like evidence has ever been produced; and if we only consider that chemical attraction necessarily involves combination, atom to atom, and, consequently, disorganization of all vegetable structure; that cotton wool may be died without injury to its fibre, and that that fibre remains entire, when, by chemical means, its color has again been removed, we shall find that the union of cotton with its coloring must be accounted for otherwise than by chemical affinity. In particular processes, as we shall afterwards see, attraction is no doubt exerted; but it is an attraction connected with structure, and, therefore, more mechanical than chemical.

When we examine with a powerful microscope a fibre of cotton, dyed either with indigo, with oxide of iron, chromate of lead, or the common madder-red, the color appears to be spread so uniformly over the whole fibre that we cannot decide whether the walls of the tube are dyed throughout, or that the coloring matter only lines their internal surface. But the microscope shows that the collapse which occurs in raw and bleached cotton is very considerably diminished in the dyed.

The greater number of specimens of Turkey-red, which I have examined, show the same uniformity of color; but in others of them, little oblong balls appear all along the inside of the tube, of the fine

pink shade of that dye, while the tube itself is colorless. It is in stout cloth dyed in the piece that these rounded masses occur, and the observation has been confirmed by several of my friends who are practiced in microscopic research. But I shall resume these observations with a more perfect instrument, which I hope soon to possess.

We have moreover the powerful analogy of the arrangement of coloring matter in plants, in support of this view of the case. "Cellular tissue," says Dr. Lindley, in his Introduction to Botony, "generally consists of little bladders, or vesicles, of various figures adhering together in masses. It is transparent, and, in most cases, colorless; when it appears otherwise its color is caused by matter contained within it." . . . . "The bladders of cellular tissue are destitute of all perforations, so far as we can see, although, as they have the power of filtering liquids with rapidity, it is certain that they must abound in invisible pores." . . . . "The brilliant colors of vegetable matters, the white, blue, yellow, scarlet, and other hues of the corolla, and the green of the bark and leaves, is not owing to any difference in the color of the cells, but to the coloring matter of different kinds which they contain. In the stem of the garden balsam, a single cell is frequently red in the midst of others which are colorless. Examine the red bladder, and you will find it filled with a coloring matter of which the rest are destitute. The bright satiny appearance of many richly colored flowers depends upon the colorless quality of the tissue. Thus in *Thysanotus fascicularis*, the flowers of which are of a deep brilliant violet, with a remarkably satiny lustre, that appearance will be found to arise from each particular cell containing a single drop of coloring fluid, which gleams through the white shining membrane of the tissue, and produces the flickering lustre that is perceived." Cotton is itself cellular tissue, and the ligneous basis of all the forms of these vessels has the same chemical constitution.

I have alluded to another class of processes in dyeing in which the action much more resembles chemical affinity. I mean that in which pure cotton, by mere immersion in different liquids, withdraws a variety of substances from their solution. The "indigo vat" is a transparent solution, of a brownish yellow color, consisting of deoxidized indigo combined with lime, and containing seldom more than $\frac{1}{500}$th of its weight of coloring matter. By merely dipping cotton in this liquid, the indigo attaches itself to it in the yellow state, in quantity proportioned within certain limits to the length of the immersion, and all that is then necessary to render it blue is to expose it to the air. Here an inactive spongy substance exercises a power which overcomes chemical affinity, but the mixture, which is formed of cotton and indigo, possesses none of the characters of a chemical compound. We can only recognize, in this action, the same force, whatever that may be, which enables animal charcoal to decolorate similar liquids. Charcoal, as we have also seen, withdraws metallic oxides from their solution in alkalies. Cotton wool has the same power, and it is extensively used as a means of dyeing with the yellow and red chromates of lead. If lime in excess be added to sugar of lead, dissolved in a considerable quantity of water, the lead which

precipitates is redissolved in the lime water, and forms a weak solution of plumbate of lime. If a piece of cotton be immersed in this solution it appropriates the lead, and when afterwards washed, and dipped in a solution of chrome, the lead becomes chromate of lead.

The same force enables cotton to imbibe basic salts of iron and tin by immersion in certain solutions of these metals; and many other examples of what Berzelius calls a cytalytic force, in decomposing weak combinations, will occur to those who are familiar with the art of dyeing.

It appeared to me interesting to compare the amount of surface exposed by cotton wool, with that of the more minute divisions of charcoal. I am enabled to furnish the following calculation through the kindness of Professor Balfour, who has measured with great care the fibres of various qualities of wool. The fibre of New Orleans wool varies most commonly from $\frac{1}{1500}$th to $\frac{2}{2000}$th of an inch in diameter. About forty of these fibres, or tubes, compose a thread of No. 38 yarn, (thirty-eight hanks to the pound.) Ordinary printing cloth, has, in the bleached state, 493 lineal feet of fibre, or 10.6 square inches of external surface of fibre in a square inch, which weighs nearly one grain. It is easy to compress 210 folds of this cloth into the thickness of one inch. It has then a specific gravity of 0.8. One cubic inch has 94.163 lineal feet of tube, and 16.8 feet of external surface; or, if we include the internal surface, there are upwards of 30 square feet of surface of fibre in one cubic inch of compressed calico. The charcoal of box-wood, has, as we have seen, 73 square feet of surface to the inch, with a specific gravity of 0.6.*

Lond., Edin. & Dub. Phil. Mag.

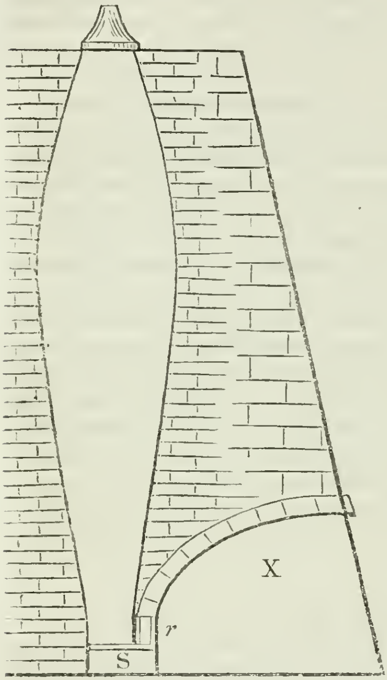
Improved Lime-Kiln.

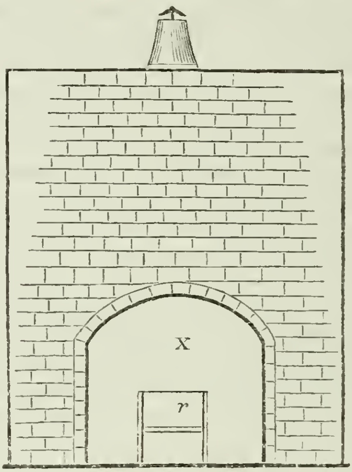
Having represented to Mr. Duffus, the scientific curator of the Royal Dublin Society's Agricultural Museum, that we had received very many inquiries respecting an improved lime-kiln, and requested his assistance to enable us to present the plan of one to our readers, he has kindly complied with our request, by sending us a sketch, from which the accompanying wood cut was prepared, together with the following description:—

Sir,—The lime kiln, of which I have sent you a sketch, is one of the best and cheapest of those in use at Closeburn. The interior is circular, and the outline, as seen in the sectional elevation, resembles that of the body of a salmon: the diameter at the fuel-chamber is 3 feet—at 20 feet from the grating the diameter is 7 feet, contracting again to 3 feet at the top; and the entire height of kiln is 36 feet, 2 feet of which are below the grating. There are double cast-iron doors for the fuel-chamber, placed at 9 inches, or a foot, asunder; the space between being filled with air, the escape of heat is effectually prevented. These doors are at *r;* they are 3 feet wide by 1½ foot

* For drawings of cotton and linen see Philos. Mag., Nov. 1834, (S. 3, vol. v, p. 355.)

high. One door of the same size is on the ash-chamber. The grating over the ash-chamber S, is constructed of hollow bars of iron; the hollow admits a current of air, and prevents the decay of the bars. The bars are two inches wide, 3 inches deep, and the metal ¼ inch thick. Through the door above the grating, the burnt shells are withdrawn; through the door below, the lime ashes are taken out.





Besides the air admitted through the ash-chamber, there are side openings for additional supplies of air, and by means of which the draught may be regulated. This is an important object to keep in view; if the draught be too strong, the lime-stone is apt to be vitrified. To save the expense of doors, the side openings may have stones fitted to them, to be put out, or in, at pleasure. X, is the covered area under which the lime lies to cool, and carts are loaded; it is 12 feet high, by 10 feet wide at the mouth.

The internal masonry of the kiln should consist of fire bricks; the masonry in front may be either brick, or stone.

The kiln, of which you have here a sketch, is built on the side of a bank, which is always the most convenient site when the nature of the place affords it. A bank beside a lime-kiln, is, in fact, a machine erected and worked without cost, inasmuch as it saves the inclined plane, or tackle, that would be necessary if the kiln was built in the midst of a plain.

The kiln is furnished at the top with Booker's conical cover; it

turns on a pivot in its periphery, and rests on a curb-ring fixed to the masonry. It is 3 feet in diameter at base, and 3 feet high, with an opening of 1 foot at the top. Over this opening Menteath places a lid for regulating the draught, or for keeping out rain; instead of which I would add to the conical cover a small iron *umbrella*, that might be screwed up, or down, at pleasure. This I have sketched in the front elevation. It is necessary to put on the lid of a rainy day, at a time, perhaps, when the greatest draught of air is required. The umbrella cover would have this advantage—it would admit of a great draught, and yet effectually exclude the rain.

A kiln of this construction possesses many important advantages. Some of these advantages will be readily seen by an inspection of the sketch. The double doors, by confining the air between them, economize the heat—an object, towards the attainment of which, the shape and proportion of the entire structure greatly contribute.

The cover keeps in the heat, and keeps out the rain. When the rain is freely allowed to fall on the kiln, it wastes the heat, and also the space, by slackening the lime.

As respects the useful effect, Mr. Menteath says, (*High. Soc. Trans.* vol. viii,)—"These narrow kilns admit of there being drawn out of them every day, if fully employed, more than two-thirds, or nearly three-fourths, of their contents of well burnt lime, and afford fully three of lime shells for one measure of coal, when large circular kilns will not give out more than one-half of their contents every day, and require nearly one of coal for every two measures of lime."

I have not attempted to give you an estimate of the expense, as that can easily be done by any builder in the locality where a kiln is intended, who must of course, know the expense of fire bricks, workmen's wages, &c., in that locality. Suffice it to say, that a kiln of this construction will be found one of those things that soon affords abundant remuneration for the original outlay. I remain, &c.,

February 12th, 1844. J. Duffus.

Lond. Farmer's Mag.

On the Chemical History of Sugar. By Mr. Fownes.

After a slight description of the properties and distinctive characters of the more important of the sweet principles of the vegetable kingdom, the lecturer proceeded to discuss the subject of the practical manufacture of raw and refined sugar from the juice of the cane. The sugar-cane itself, originally a native of India, or China, was introduced into Sicily, by the way of Egypt and Syria, at a period antecedent to the crusades. It was carried, in 1420, by the Portuguese to Madeira, and, subsequently, by the same people, and the Spaniards, to Brazil, and to the West India Islands. The process of sugar making in the British West India colonies, has probably undergone but little change for two centuries, or more, except in the improvement of the machinery for crushing the ripe canes, and extracting the juice. The tempering with lime, clarifying by heat, and quick evaporation

in a series of open pans, still remain. Under the most favorable circumstances, a large quantity of molasses is always produced ; and, as we know from the experiments of M. Peligot, that nothing but crystalizable sugar exists in the juice of the cane, this production of treacle must be ascribed to an alteration of the sugar from the high temperature of the liquid in the open pans towards the termination of the boiling. The excellent plan now adopted by the refiners of the raw, or Muscovado, sugar, for concentrating their purified and bleached sirop, by evaporation, in vessels from which the air is exhausted, patented in 1813, by the Hon. C. E. Howard, was then described and illustrated, and its adoption in the sugar islands, for concentrating to the necessary degree the clarified cane juice, strongly recommended. Under this system the product of sugar would be greatly increased, and its quality much improved, while little uncrystalizable sirop would be produced. This is, however, but a part, although an essential one, of the improvement of which the sugar cultivation and manufacture are susceptible. The East India sugars are made in part from the juice of a palm; the crude product, or *jaggery*, is subjected to a kind of refining process before exportation. These sugars are softer and less crystaline, and inferior in sweetness to those of the West Indies. The cause of the latter fact is to be sought for in the quantity of *grape sugar* they contain, which, indeed, is found more, or less, in every sample of raw sugar, having been produced in the first boiling at the expense of the crystalizable portion. For the purpose of detecting the presence of the grape sugar, recourse may be had to a beautiful experiment of Trommer, described in the "Annalen der Chemie und Pharmacie," for 1841, p. 360. The sugar to be examined is dissolved in water, mixed with a solution of sulphate of copper, and then a large excess of caustic potash added. The blue precipitate at first thrown down is redissolved with intense purplish-blue color by the excess of alkali. So far, both cane and grape sugar behave alike ; but on heating the liquid to the boiling point, the cane sugar solution undergoes but little change, while that containing the grape sugar yields a copious precipitate of brilliant red sub-oxide of copper. It was suggested that this experiment might possibly be put into a form applicable to the *assay* of sugars, in which the proportion of grape sugar—that is, worthless sugar—should be inferred from the quantity of sub-oxide of copper produced from a given weight of the sample. The cheaper kinds of raw sugar, chiefly consumed by the poor, are sometimes cruelly adulterated by an intentional admixture of grape sugar, manufactured on a large scale for the purpose from potato-starch. This is a fraud which should be suppressed.

Civ. Eng. & Arch. Journ.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On Compensating Pendulums.

At the meeting of the Société Philomathique, held July 29th, 1843, M. Vincent, in behalf of M. Egger, Professor of Greek Literature in

the Faculty of Arts, communicated a method of constructing compensating pendulums, in which the two metals employed are connected by joints, and which have, in consequence, the advantage of being entirely free from all want of homogeneousness, arising from soldering. This method is founded upon the following principle:—Let a, be the hypotenuse of a right angled triangle, and b, one of the sides adjacent to the right angle. If these two lines are represented materially by metallic rods of different kinds, the third side h, will retain a constant length, provided the lengths of a and b, and their respective coefficients δ, and δ^1, satisfy the following conditions:—

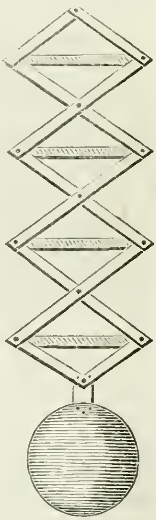
$$a^2 - b^2 = a^2(1+\delta)^2 - b^2(1+\delta^1)^2,$$

whence, in neglecting the very small fractions of the second order,

$$a^2\delta - b^2\delta^1 = 0, \text{ or } a : b :: \sqrt{\delta^1} : \sqrt{\delta}.$$

If, for example, the hypotenuse a, is of iron, and the side b, of brass, we shall have $\delta^1 : \delta :: 19 : 12$, very nearly, whence

$$a : b :: \sqrt{19} : \sqrt{12} :: 5 : 4, \text{ very nearly.}$$



Thus we shall obtain a sufficiently perfect compensation by a hypotenuse of iron = 5, and one side of brass = 4, whence it follows that the other side will be represented by 3, which we will assume as the height.

Nothing is more easy to construct than this figure; it is the celebrated triangle with which Pythagoras discovered the proposition of the square of the hypotenuse.

To apply it, suppose we place together four triangles, so as to form a lozenge, of which the sides are iron, and = 5, while one diagonal of brass = 8: the second diagonal, (the matter of which is of no importance,) will = 6, whatever may be the temperature. Now let us imagine a series of these lozenges arranged together firmly, one above the other in the same vertical plane; and to this effect, suppose iron bars the length of each = 5, first united two by two, in the form of a cross, and joined by their middles, then let the different couples be united and joined together by their ends, so that all the centres shall be in the same vertical line; and let the adjoining couples be separated from each other by horizontal brass bars each = 4. The total height of this system will remain constant, and equal to 3, multiplied by the number of lozenges: this height will be the length of the pendulum. —*L'Institut.*

Jeffery's Patent Marine Glue.

In the course of a series of experiments which Mr. Jeffery tried with various substances, he succeeded in discovering the composition

to which he has given the name of "marine glue," the peculiar properties of which are its being insoluble in, and impervious to, water; elastic, so as to expand, or contract, according to the strain on the timber, or the changes of temperature; sufficiently solid to fill up the joints, and add strength to the timber construction; and adhesive, so as to connect the timbers firmly together.

To make the marine glue:—A solution is first made of caoutchouc of good quality with coal naphtha, in the proportion of one pound of the caoutchouc to five gallons of the naphtha. The caoutchouc is cut into thin shreds before being used; and the mixture is stirred until the caoutchouc is so dissolved as to bring it to the consistence of thick cream. Mr. Jeffery finds that the caoutchouc is sufficiently dissolved in about ten, or twelve, days.

One part by weight of the above described solution, and two parts by weight of shellac, are then put into an iron vessel. The whole is then heated and stirred until thoroughly amalgamated: and this substance constitutes the marine glue. Edin. New Philos. Mag.

Detonation of the Alloy of Potassium and Antimony.

This alloy, as is well known, may be prepared by calcining the potassio-tartrate of antimony. MM. Fordos and Gélis state, however, that when the mass has not been sufficiently heated, and the metallic alloy has not separated, a porous mass is obtained composed of the alloy and charcoal, which detonates without being moistened, and by the mere blow by which it is attempted to be separated from the crucible; the above named chemists state that one of them was wounded by the explosion which occurred with a mass of this alloy. *Journ. de Ph. et de Ch., Octobre,* 1843.

Lond., Edin., and Dub. Philos. Mag.

A New Constant Battery.

M. le Prince Pierre Bagration has invented a new and simple constant galvanic battery, the particulars of which have been communicated by M. Jacobi, to the Academy of Sciences, at St. Petersburgh. Its elements are zinc, copper, and sal ammoniac; common earth saturated with the latter acting as a porous diaphragm. A plate of copper, and a plate of zinc, placed at a distance, the one from the other, in a flower-pot, or any other water-tight vessel, filled with earth saturated with a concentrated solution of sal ammoniac, form a voltaic pair, whose action will, after a short time, continue constant, and be maintained for whole months, and, to every appearance, for years; the only care necessary being from time to time to remoisten the earth, and renew the zinc. Before putting the copper plate into the earth, it should be plunged for some minutes in a solution of sal ammoniac, and then left to dry, until it receives a greenish coating. This operation renders the effect of the battery much more prompt;

and in regard to it, brass may be preferable to copper. The plates should not be too near each other, nor too small, because the earth opposes great resistance to the current. This form of battery is susceptible of many applications, but it will chiefly be useful where a constant and prolonged action, rather than energetic effect, is required; as, for example, in the reduction of metals, chemical decomposition, &c. It may be extended, however, to any quantity, or intensity. Whenever a series of numerous elements is used, the vessels should be well insulated. M. Jacobi has had one of the sal ammoniac batteries of twenty-four elements in action for six weeks, without the necessity of making the least change in it.

English Patents.

Specification of a Patent granted to Frederick Steiner, *of the county of Lancaster, for a new manufacture of certain Coloring Matter, commonly called Garancine.—Sealed August* 8, 1843.

My invention consists in manufacturing a certain coloring matter called garancine, from refuse madder, or madder which has been previously used in dyeing; such madder having, prior to the said invention, ordinarily been thrown away as spent, and of no value; and the said coloring matter called garancine, having been produced heretofore from fresh, or unused, madder. And I do further declare in what manner the said invention is to be performed as follows:—Outside the building in which the dye vessels are situate, I construct a large filter, formed by sinking a hole in the ground, and lining it at the bottom and sides with bricks, without any mortar to unite them. Upon the bricks I place a quantity of stones, or gravel, and over the stones, or gravel, common wrappering, such as is used for sacks. Below the bricks is a drain to take off the water which passes through the filter. In a tub adjoining the filter is kept a quantity of dilute sulphuric acid, of about the specific gravity of 105, water being 100. Hydro-chloric acid will answer the several purposes for which I use sulphuric acid, though I prefer sulphuric acid as more economical. A channel is made from the dye vessels to the filter. The madder which has been employed in dyeing, and which is in the state considered as spent, or refuse, madder, is run from the dye vessels to the filter, and while it is so running, such a portion of the dilute sulphuric acid is run in, and mixed with it, as changes the color of the solution, and the undissolved madder, to an orange tint, or hue. This acid precipitates the coloring matter which is held in solution, and prevents the undissolved madder from fermenting, or otherwise decomposing. When the water has drained from the madder through the filter, the residuum is taken from off the filter, and put into bags. The bags are then placed in a hydraulic press, to have as much water as possible expressed from their contents. After the press has been applied to the bags, I generally find about one-half, or two-thirds, of their

contents to consist of water. In order to break the lumps which have been formed by compression, the madder, or residuum, is passed through a sieve. To five cwt. of madder in this state, placed in a wood, or lead, cistern, I add one cwt. of sulphuric acid of commerce, by sprinkling it on the madder through a lead vessel, similar in form to the ordinary watering can used by gardeners. I next use an instrument like the garden spade, or rake, to work the madder about, so as to mix it intimately with the acid. In this stage I take the madder and place it upon a perforated lead plate, which is fixed about five, or six, inches above the bottom of a vessel. Between this plate and the bottom of the vessel, I introduce a current of steam by a pipe, so that it passes through the perforated plate, and the madder which is upon it. During this process, which occupies from one to two hours, a substance is produced of a dark brown color approaching to a black. This substance is garancine, and insoluble carbonized matter. I next throw this substance on the floor to cool. When cool, I place it upon a filter, and wash it with clear, cold water, until the water passes from it without an acid taste. I then put it into bags, and press it with a hydraulic press. I next dry the substance in a stove, and grind it to a fine powder, under ordinary madder stones, and afterwards pass it through a sieve. In order to neutralize any acid that may remain, I add for every cwt. of this substance from four to five pounds of carbonate of soda in a dry state, and intimately mix them. The garancine in this state is ready for use.

Having now described the nature of the said invention, and the manner in which the same may be performed, I hereby declare, that I do not claim as of the said invention, or the exclusive use of the said several processes and operations herein before mentioned, except when the same are employed for the manufacture of garancine from spent, or refuse, madder. But I claim as my invention the manufacture herein before described of the coloring matter called garancine, from madder which has been previously used in dyeing, and which is usually called spent madder. And such invention being, to the best of my knowledge and belief, entirely new, and never before used within that part of her said majesty's United Kingdom of Great Britain and Ireland, called England, her dominion of Wales, and town of Berwick-upon-Tweed, and I do hereby declare this to be my specification of the same, and that I do verily believe this, my said specification, doth comply, in all respects, fully, and without reserve, or disguise, with the proviso in the said herein before in part recited letters patent contained; wherefore, I do hereby claim to maintain exclusive right and privilege to the said invention.—[Enrolled February 8, 1844.

Reper. Arts and Pat. Inven.

Specification of a Patent granted to William Daniel, *of the county of Monmouth, for improvements in Rolling Iron into Plates, or Sheets.—Sealed July* 22, 1843.

My invention relates to improvements in the manufacture of thin

plates, or sheets, of iron suitable for making tinned plate, and for other uses; and in order that my invention may be fully understood, and readily carried into effect, I will proceed to explain the means pursued by me.

In the manufacture of thin sheets of iron suitable for the making of tinned plate, and for uses where similar thin sheets of iron are required, it was formerly usual, and is still commonly the case, to subject the iron to repeated processes of piling and re-heating, by which, not only was much fuel employed, but the iron was much wasted; and in the repeated rollings, the rolling after each piling and re-heating was in the same direction, and the iron was rolled into bars about half an inch thick, and about six inches wide; the bars thus obtained were cut into lengths at the tin plate mill, and subjected to rolling between hard rollers, in the reverse direction to that in which they had before been rolled. Now, according to my invention, I avoid the repeated processes of piling, heating, hammering, and rolling of the iron, before reversing the direction of the rolling, and I obtain, not only a considerable saving of fuel, but, by avoiding the repeated piling and heating processes, heretofore considered necessary before reversing the direction of the rolling, I save the consequent cost of those, and of the successive processes of hammering and rolling after re-piling and reheating, and, at the same time, I produce superior thin sheets, or plates, of iron. In carrying out my invention, I take a ball of iron from a charcoal refinery, or from a puddling furnace, and submit it to the hammer, and then roll it into a bloom of about six inches wide, and five inches thick; I cause this bloom to be cut by a saw, or other convenient means, into lengths of from four to six inches, or other convenient length. These pieces are then to be immediately rolled, the grain of the pieces, when passing through between the rollers, being kept vertical, by which the upper and under surfaces of the bars produced therefrom will be the clean cut surfaces; and I roll each of these pieces till they are successively brought into bars about five inches wide, and two and a half inches thick, and with proper care no re-heating is required up to this process. And I would here remark, that although this process is necessary to the obtaining the upper and under surfaces according to my invention, I do not claim, generally, the rolling of iron into thin sheets, after cutting of blooms, and causing the pieces thereof to be rolled with the grain vertical, that mode of obtaining good surfaces having formed the subject of claim to invention under letters patent granted to me, bearing date at Westminster, the 16th day of April, 3 Geo. IV., in the year of our Lord 1822; but when making thin sheets, or plates, of iron, according to that invention, I caused the bars obtained to be repeatedly cut up and piled, re-heated, hammered, and rolled, retaining the cut surfaces above and below to the end of the process, continuing the rolling after each piling in the same direction as before, and the iron was brought into a bar of about half an inch thick, and six inches wide, which, being taken to the tin plate mill, was cut into lengths, and rolled into thin plates, or sheets, reversing the direction of rolling. Now, according to my present improvements, I avoid all those pro-

cesses of piling, hammering, re-heating, and rolling, before reversing the direction of rolling. I commence at once to roll in the transverse, or opposite, direction, on pieces of iron which have been produced from the cut bloom, as herein described; therefore, the bars of iron obtained by rolling the grain when vertical, after cutting, as above explained, in place of being repeatedly cut up, piled, heated, hammered, and rolled, in the same direction, are, according to my present invention, to be finished into thin plates, or sheets, by rolling the pieces thereof in the reverse direction to that in which the bars were rolled; and for this purpose I cut the bars into lengths according to the sizes of the plates to be made therefrom, and these pieces I cause to be heated in a suitable furnace, and I cause them to be rolled in grooved rollers, the width of the grooves being the same as the length of the pieces of iron, and the pieces of iron are to be rolled and lengthened out in a direction at right angles to the previous rolling, and I continue such rolling in successive grooves till the iron is reduced to about one-eighth of an inch in thickness, the width remaining about the same as the length of the piece of iron was before commencing rolling it at right angles to the direction in which the piece had been previously rolled. A piece of iron thus treated will then be in the state of what is technically called "a moulding," which is to be completed in a tin plate mill, by being cut into suitable lengths, and heated to a low red heat, and passed between hard rollers, as is well understood, then doubled, and again heated to a low red heat, and again rolled by hard rollers, and again doubled, and heated again to a red heat, and rolled into "black plate," the rolling being in the way of the length of the sheet, or plate; that is, I continue to roll the iron in the same direction, between the hard rollers, as it was rolled before coming to the hard rollers.

I would remark that I prefer to use the best refinery iron for the purposes of my invention, at the same time, I do not confine myself thereto, as thin sheets, made according to my invention, from puddling iron, will be found superior to the plates made of the same iron by the modes heretofore resorted to, in addition to which, there will be a great saving in making such plates, or thin sheets, according to my invention.

Having thus described the nature of my invention, and the manner in which the same is to be performed, I would wish it to be understood, that I do not confine myself to the precise details, so long as the peculiar character of my invention be retained. But what I claim, is the mode of rolling iron into thin sheets, or plates, for the manufacture of tinned plates, and other uses, by causing pieces of iron to be rolled out into sheets, or plates, by rolling them at right angles to the direction in which they have been produced, when such pieces have been obtained by rolling cut-iron with the grain in a vertical direction, the upper and under surfaces being those which result from the cutting, as above described.—[Enrolled January 22, 1844.]

Ibid.

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